Examining Diets, Identities, and Entanglements of Coast Salish Dogs

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ABSTRACT

The Coast Salish of southern Vancouver Island maintained domestic dog populations for over 6000 years. Using a multi-scalar approach, including oral tradition, isotopic dietary analysis of dog remains from six archaeological sites (DiSe-7, DcRu-12, DiSc-1, DjSf-13, DjSf-14, & DjSe-6) and radiocarbon dating, this project addresses the agency of dogs and their unique entanglement and relationships with humans. Through multiple lines of evidence, the interwoven relationships between dogs and their humans are explored and the following questions addressed: 1) what foods were dogs eating? 2) What is the dietary variability on the Pacific Northwest Coast over time and space? 3) How can these data, combined with ancillary lines of archaeological evidence, be used to interpret human-canine entanglement through relational approaches? Stable carbon and nitrogen isotope ratio analyses of 60 samples indicates that dogs were consuming mainly high-trophic marine-based proteins, consistent with previous palaeodietary research in coastal British Columbia, which indicates a primarily high-trophic marine diet for both humans and dogs along the coast. New radiocarbon dates are produced for six sites (two previously undated) indicating long-term associations between species over time and space within the region. The presence and personalities of dog characters from Coast Salish traditional narratives in conjunction with dietary stable isotope data and radiocarbon dates provides us with insights into human-dog relationships in this region.

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RESEARCH CONTRIBUTIONS

Conference Presentations

2019 **Sparrow, A.**, Harris, A., and Burchell, M.
Investigating Diet, Identity, and Human-Dog Relationships using Archived Collections from Vancouver Island. Poster presented at the 52nd Annual Meeting of the Canadian Archaeological Association, Quebec City, May 15-19 2019.

2018 Burchell, M., **Sparrow, A**., Dusseault, M., Hallman, N., and Schöne, B.R.
The Mid-Holocene Landscape of Deep Bay: A Multi-Proxy Approach to Palaeoenvironmental Reconstruction from Shell Midden Deposits in Coastal British Columbia, Canada. Paper presented at the 130th Annual Meeting of the Geological Society of America, Indianapolis, Indiana, November 4-7 2018.

2018 **Sparrow, A.**
New Tricks for Old Dogs: Investigating Diet, Identity, and Human-Dog Relationships of the Coast Salish. Paper presented at the 24th Annual Meeting of the European Association of Archaeologists, Barcelona, Spain, September 5-8 2018.

2017 **Sparrow, A.**
Revisiting Deep Bay: Interpretations of Seasonal Subsistence Practices through Shell Growth Increment and Stable Oxygen Isotope Analyses. Poster presentation, 50th Annual Meeting of the Canadian Archaeological Association, Ottawa-Gatineau, May 10-13 2017.

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Shellfishing through the Holocene in British Columbia: Insights from Oxygen Isotope Sclerochronology. Poster presentation, 4th International Sclerochronology Conference, Portland ME., June 5-10 2016.

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Interpreting Shellfish Harvesting in Port Joli Nova Scotia: A New Technique Using Micro-Growth Pattern Analysis. Poster presentation, 48th Annual Meeting of the Canadian Archaeological Association, St. John's, NL., April 31-May 2, 2015.

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PREFACE

Academic ideas and processes are informed by an individual's real-world experience. We speak about *agency* in archaeological theory, connecting the idea to others in the past, but sometimes neglect to acknowledge its influence in our own research. Researchers spend two years or more (often many more, sometimes decades) working on a project with the same materials, from the same landscapes. We spend hours, days, weeks, months, teasing out ideas about the past from our accumulation of data. We become emotionally invested in our work. We spend our free time with our projects, shaping and building them. It becomes part of us.

Outside influences affecting our non-academic lives directly affect the quality and dynamics of our academic lives. A large number of students launching into a graduate degree are in their 20s and 30s, many just beginning to navigate their adult lives on their own. Some are experiencing personal losses and grief. Many work part- or full-time side jobs to supplement their incomes. Some have children, some choose not to. We all fall in and out of love – with friends, lovers, our colleagues, our research. Some people dive into their projects headfirst to soothe their anxieties while still others float off, unable to anchor fully for one of a hundred reasons.

A dog named Bear came into my life several years ago. He was around four at the time and as rambunctious as any young golden retriever can be. He and my big, serious mutt, Brody, took a while to warm up to each other, but now they are inseparable. We have all had many great adventures in the years that we have known each other: trail hikes, lake swims, moose encounters, car rides with the windows down. Afraid of both nothing and everything, Bear's food dish often startles him but he will lay back nonplussed during holiday fireworks while normally courageous Brody cowers in the bathroom. Bear loves to be wherever we are, and when he was diagnosed with thyroid cancer while I was beginning to write this thesis, it cut through me in a way I was not

prepared for. Bear's diagnosis was both specific and vague: malignant thyroid cancer, vascular, inoperable. It was too late. He could die next week or cling on for another six months. I had never watched a dog die and I did not know what to look for. He looked the same as always, a big goofy grin under a pair of deep brown eyes, unaware of the malignant mass in his body. I could not stop imagining coming home and finding him dead. I continued to picture different gruesome scenarios, over and over and over, a constant loop of agony repeating itself in my head. I felt like I was existing underwater.

During my descent, I did what any good academic does: I researched. I read every editorial and column on every website and found every peer-reviewed article I could find about canine thyroid cancer. We adjusted his diet repeatedly as he steadily lost weight no matter what he was fed. Supplements, raw diets, cooked foods, rice and chicken, kibble, oils, CBD; nothing stopped the chronic diarrhea or startling weight loss. His neck is now swollen to the size of a small melon. If you run your hands down his throat, you can feel lumps like softballs under his fur. The skin around his sternum is concave and taut. The tumour has not yet affected his breathing or appetite, somehow, but I watch him vigilantly, pain indicators and quality-of-life checklists floating like dark jellyfish in the back of my mind, waiting to sting when we are unprepared.

Bear is prescribed two pills per day to increase his thyroid's thyroxine production. He will not eat them, even if they are hidden inside his favourite tasty foods. We have to gently push one of the small pink pills down his throat before his breakfast and do it once again before supper, but he does not understand why he must swallow them. He does not know he is sick. He thinks it is a new kind of game. The pills are discovered hours later in my shoe, under the living room rug, outdoors in the grass. His tail wags when we find them.

Writing about dogs, specifically writing about extraordinary bonds between two species over thousands of years while our own dog wasted away at our feet became difficult. For over a year, I drifted in and out, presenting myself for major academic events and attending conferences but finding myself unable to prepare. My laptop sat untouched for weeks at a time. Seeing an email notification on my phone made my heart race. I vanished from my cohort. I felt extraordinary guilt for every moment I wasn't writing, but couldn't make my body respond to my mind's restlessness. I was struggling with anxiety and depression while grieving a still-living dog. The decline of my academic life is visible while flipping through my notebooks. Many of them contain neat notes, careful illustrations. Lots of highlighter. Grand quotes and small, thoughtful notes. It appears as though I actually used to be good at this. I can't believe some of these ideas actually came from my head. After many pages, the penmanship gets sloppier and the notes go unfinished. Drawings become doodles. Then the pages become blank. I had been swallowed.

A full year passed before I slowly became more confident that Bear's death was not immediately imminent. He was sick, yes, but he was just a very thin version of the same Bear I always knew. We moved into a house with big windows that let in lots of sunlight, I forced myself to spend more time outdoors, and I started to budget time in my life for creative pursuits. I commenced a second attempt at writing this thesis by focusing on the theory and the bonds between dogs and their people. Writers are told to *write what you know*. Mindfully examining my own relationships with my dogs, and the networks of human-dog relationships of those around me, has influenced my understanding of the potential relationships of dogs and people in the past.

Bear's cancer has done irreparable damage to his body. We are no longer focussed on trying to heal him, but instead on making him as happy as he can possibly be while he is still comfortable. We sprinkle bacon bits or dollop plain yogurt on his dinners. We take meandering

walks around the neighbourhood. We spend our spare time in the backyard, playing fetch and drinking from the garden hose. His quality of life is, for now, very good. My personal research shifted, also, from cancer treatments to palliative care and at-home euthanasia options. I still cry sometimes when I read the articles. We watch closely for pain and anxiety and weigh the good days against the bad. So far, they are still good, and I hope that these good days continue.

We are all influenced by our lives and events outside of academia, whether or not we attempt to be fully objective. Self-reflexivity is necessary when studying archaeological remains, particularly when our lived experiences and academic topics are imbricated. Bear's diagnosis dramatically affected my mental health, which in turn affected my academic life and research. I hope that writing publicly of my own experiences will encourage others to prioritize their own mental health during periods when they are struggling to stay above water.

The discussion of mental health in academia is fledging but has not fully taken off[1], even though so many researchers suffer from mental health issues[2]. Academia is hyper-competitive[3,4], fast moving, and unforgiving. Throw imposter's syndrome into the mix (extremely common in early-career researchers and academics[5]) and we have created an environment that naturally begets mental illness. Researchers must constantly produce content and data, we must always be pushing forward in order to succeed, but that leaves us exhausted with little time for us to stop and reflect on anything else[6]. Mental health issues are prevalent in academia, particularly among graduate students who are taught that it is normal to cry all the time, who are expected to exist on

[1] https://www.nature.com/articles/d41586-019-01468-0
[2] http://theconversation.com/more-academics-and-students-have-mental-health-problems-than-ever-before-90339
[3] https://lucklab.ucdavis.edu/blog/2018/7/4/job-market
[4] https://www.timeshighereducation.com/news/hypercompetition-reshapes-research-and-academic-publishing
[5] A, Parkman (2016) The Imposter Phenomenon in Higher Education: Incidence and Impact. *Journal of Higher Education Theory and Practice* 16(1):51-60
[6] https://chroniclevitae.com/news/1026-there-s-no-crying-in-graduate-school

a budget tighter than a shoestring[7], who are told it is necessary to prioritize research over all else in order to stay relevant. Panic attacks, anxiety, and depression are normalized as *just the way things are* in graduate school. I was lucky enough to connect with a supportive supervisor who is empathetic to mental health struggles; many students do not have the same experience.

This is not a sustainable way for an individual to live, nor is it a healthy environment to conduct research. If we want to learn about the world around us and have an actual positive impact on that world – and I truly think that is why so many of us are drawn to academia to begin with – then we need to be more open about our experiences and emotions with one another in healthy ways. We cannot change the world if we forever doubt our work and our selves, and that will not change until we fully commit to supporting each other in a positive way. We are often encouraged to keep our problems to ourselves in academia in fear of being passed over for grants, positions, jobs, but our non-academic lives inevitably seep into our academic careers, whether we want them to or not. Academia is, when you get down to it, a job – one that usually requires huge amounts of time, money, and emotional labour to sustain. This often pushes the rest of our lives to the wayside. Mindfully examining the ways in which we interact with one another while practicing empathy and kindness could make a considerable impact on the quality of life of those around us.

[7] One tip urges graduate students to "not eat too much" in order to save money: https://www.apa.org/science/about/psa/2013/06/broke-students

CHAPTER 1: Introduction

Project Outline & Research Objectives

Dogs and humans have been intertwined socially, emotionally, and physically for thousands of years. We have shared tangible things such as food and shelter, as well as intangible things like companionship, labour tasks, and to a degree, language. In addition to possessing a basic recognition and understanding of verbal human language and physical signals, dogs have developed very effective methods to communicate their needs and desires to their human companions. Dogs were the first domesticated animals, with the earliest known domestic specimens estimated to be between 11,000 and 36,000 years old (Crellin 1994; Davis and Valla 1978; Druzhkova et al. 2013; Guagnin et al. 2017; Ovodov et al. 2011). Our relationships and bonds with dogs have developed and deepened over time and space within almost every human culture around the world.

The earliest known dogs in North America originated from Siberian decent rather than being domesticated from North American wolves (e.g., Larson et al. 2012; Leathlobhair et al. 2018). Early dogs are a subject of modern curiosity, and dogs remain exceptionally important today within most living human societies. Not only did humans and dogs simply live within a close proximity to one another - there is also archaeological evidence that humans have been caring about the health and welfare of dogs for thousands of years (e.g., Janssens et al. 2018; MacKinnon 2010; Marino 2015). The expansive temporal and spatial scale in which we have so closely coexisted has created a relationship between species that is intimate, complementary, and exceptionally complex.

Dogs can reliably be used as proxies for understanding human diet in some circumstances (e.g. Burleigh and Brothwell 1978; Cannon et al. 1999; Guiry 2012; Noe-Nygaard 1988; West and France 2015) as dogs are inherent scavengers, coprophagic under certain circumstances, and were very likely fed directly by their human keepers. While recognizing that cohabitating omnivores

would likely share a similar diet, both people and dogs had active agencies: humans actively kept dogs and the dogs were actively kept. Even though dog remains are often used in lieu of human remains when studying palaeodiet isotopically, dog remains are normally categorized and conserved as faunal material.

On the Pacific Northwest coast of North America, the Coast Salish peoples maintained dogs that fulfilled unique economic roles while occupying enigmatic social positions that were often dependent upon their relationships with humans. Archaeologists have studied dog remains of the Pacific Northwest coast and the interior. Their diets (e.g. Cannon et al. 1999; Schwarcz et al. 2014, Diaz 2019), their economic uses and importance (e.g. Schulting 1994), and their cultural significance (e.g. Amoss 1984; Crellin 1993; Marino 2013) have all been examined in some way (discussed in Chapter 2). The bonds and relationships between humans and dogs go much deeper than that human/faunal divide, particularly in the archaeological record of the Coast Salish. By adjusting the way in which we view and theorize human-animal relationships, we can provide new insights into how dogs in this context ate and existed with humans over a large temporal and spatial scale. By interpreting dog diets from the same spatial and temporal contexts as their people, this thesis seeks to understand social bonds created through food and diet.

This project uses several methods of inquiry to interpret human-dog relationships from the Salish Sea. Through the investigation of dog diet and traditional Indigenous narratives, this project addresses the relationships between domestic dogs with their human companions - particularly the potential for a personhood of dogs and the roles of dogs within Coast Salish society - within the frameworks of relational ontologies and entanglement.

These relationships can be untangled and interpreted by determining what kinds of proteins dogs were primarily eating through stable isotope analysis and by treating dogs as active agents –

the same way archaeologists typically view past human diets. The addition of new radiocarbon dates from the six sites allows spatial data to be plotted against temporal data, producing information over a long period of time and space. This dietary data can be coupled with past ethnographic information about dog diet and human relationships, as well as with traditional Coast Salish narratives involving dogs, in order to gain a better understanding of the long-term entanglement between people and dogs on the Pacific Northwest coast. Adopting different approaches, specifically human-animal entanglement, relationality, and agency, when investigating these relationships can provide new insights into how dogs were viewed and treated by people in the past.

Thesis Outline

This thesis explores the relationships between humans and dogs from six archaeological sites on Vancouver Island, British Columbia. Chapter 1 serves to introduce the reader briefly to the themes present within this project. Chapter 2 outlines archaeological links between humans and people throughout living history, the evolution and domestication of *Canis lupus familiaris*, the representation and care of dogs within human cultures, and the potential ways dogs have influenced the trajectory of human history. Theoretical frameworks including entanglement, relationality, and social zooarchaeology are also discussed. Chapter 3 discusses dogs in the archaeological record of British Columbia, specifically the ambiguity of their social roles within Coast Salish societies. This chapter also examines several traditional narratives involving dogs and a ritual known as the *dog-eater dance* and introduces the six archaeological sites from which samples were analyzed. Chapter 4 outlines the basic frameworks and methodological application of dietary stable isotope analysis, radiocarbon dating, and Fourier transform infrared spectroscopy (FTIR) used in this project. Chapter 5 discusses the results and their significance within the frameworks outlined above.

CHAPTER 2: Dogs in the Global Archaeological Record

Entanglement & Social Zooarchaeology

Entanglement theory is defined by Hodder (2014:20) as "the sum of four types of relationships between humans and things: humans depend on things, things depend on other things, things depend on humans, and humans depend on humans. This is a relational approach to looking at "the dialectic of dependence and dependency between humans and things. The term 'entanglement' seeks to capture the ways in which humans and things entrap each other, but it also seeks to recognize the ways in which a continual and exponentially increasing dynamism lies at the heart of the human experience" (Hodder 2014: 20). Although entanglement theory generally refers to human-made objects, it can also include naturally occurring objects, plants, and animals (Hodder 2011; Martindale 2009). For this research, entanglement encompasses the time and space shared between dogs and their people and the relationships created and sustained between them as individual beings.

Martindale (2009) reinterprets the archaeological history of the Tsimshian, "a group of linguistically and culturally related peoples […] [who] live in northwestern British Columbia along the Nass and Skeena rivers and on the inlets and islands between their estuaries, extending south to Milbanke Sound" (Halpin and Seguin 1990:267). Using entanglement theory, Martindale (2009) identifies ontological nuances that are historically ignored. Rather than assuming all past human action was invariably driven for economics, Martindale makes "an effort to trace the volatility of agency, the ability of individuals to effect historical consequence" (2009:62). This shift in archaeological thinking is critical for the recognition of cultural and personal subtleties. Martindale suggests that "archaeology must approach analyses of causality from an understanding that the past is dynamic, permeable, historical contextual and negotiated" (2009:85). The influence of individuals

within archaeological contexts can be interpreted through the entanglement among and between individuals – whether this individual is human or non-human.

Social zooarchaeology provides a way of interpreting archaeological faunal remains that is especially pertinent to dog remains within human cultural contexts. Animal remains in archaeology are routinely viewed as "faunal material", categorized by species, analyzed as the remains of human cultural material rather than as their own active agents. Social zooarchaeology challenges the dichotomy of the human-animal divide by recognizing animals both within and outside the context of human culture (Hill 2013; Vandergugten 2015). By considering the entanglement between humans and animals, particularly dogs, through the lens of social zooarchaeology, archaeologists can better understand the social roles of animals, their agencies, and the ontological importance of animals to past peoples. Vandergugten (2015) applies entanglement theory and social zooarchaeology to the archaeological histories of Cis-Bikal, Siberia, and Çatalhöyük, writing "alternative models that challenge Westernized distinctions between humans and animals are needed to further critical interpretation" (2015:46).

Although the entanglement between past humans with animals, plants, and items has typically been viewed as occurring between self-contained entities within dualist narratives, these relationships can also be explored between species within a relational context. The concept of "dividual", in contrast to individual, suggests that a being is constitutive through its relationships with others and aspects of its environment through fluid and dynamic enmeshment and exchange that occur as beings interact with one another. A being can occupy a space between human and non-human, a space of action and relationship, and that is how they exist (Bird-David 1999). Bird-David (1999) places the conventional concept of animism within in this context, in which animals, plants, places, and things can be regarded as non-human persons depending on the circumstances. It is the

interaction between beings that is important, rather than the idea of an animating entity within a non-human being.

Dogs in the archaeological record are categorized as inventory, included within reports of material culture rather than reported as their own unique entity. This omits the complexities of the relationships between humans and dogs, and the ambiguous status and identities that dogs often held to people and cultures around the world (e.g., Amoss 1984; Hill 2018; Losey et al. 2011, Morey 2006). While useful in many ways, traditional quantificational faunal analyses in archaeology often miss the social and emotional nuances present within human-animal relationships. Dogs in particular hold a close and unique role within human history that cannot truly be conceptualized without the augmentation of multiple lines of evidence. In the case of the Coast Salish, dogs often held ambiguous statuses of personhood without necessarily being human (Amoss 1984). This concept can be explored more thoroughly with the addition of dietary associations (i.e. dietary stable isotope analysis) to an open theoretical framework.

Relationality & the Social Significance of Dogs

The theory of relationality questions what it means to be a person, and how certain beings gain agency and personhood. Not all beings are agential people, and not all objects are beings, but within a relational framework, anything can be a person with agency at any given time through their relationships with other beings. The physical appearance of a being does not specify social boundaries, whether the being in question is an amphibian, a human, a landform, or a dog. Humans interact socially with all beings within their world. All animals have the potential to engage as non-human persons, but dogs particularly fulfill this role because of their social nature and their long-term cohabitation within human settlements. Beings can live social lives parallel to humans, and certain beings even exist as humans until interaction with humans occur, at which time they can

change form. Losey (2010:19) states that any objects or beings can "reveal themselves as animate through their engagement with other beings." Viewing the relationship between humans and dogs within a relational framework, in which a being is constitutive through its relationships with others and aspects of its environment, a being can occupy a space between human and non-human, a space of action and relationship (Bird-David 1999). Animals, plants, places, and things can be regarded as non-human persons depending on the circumstance. Some dogs were considered non-human persons, dependant on their relationship with humans –and inversely, dogs would likely have viewed certain humans as non-canid dogs, pack-mates in a way, and others as simply animals of another species.

Hallowell (1960:21) states: "While in all cultures 'persons' comprise one of the major classes of objects to which the self must become oriented, this category of being is by no means limited to human beings." Within a relationally animistic framework, this emphasizes the relationship between a non-human being and a human, allowing for the classification of a non-human being as a person. The term 'non-human persons' is an encompassing term which accurately reflects this framework. Ingold (1988:9) suggests, "if we accept that animals other than human beings may be conscious, intentional agents, then we have also to ascribe to them personal as well as natural powers. That is, we are forced to recognize that they embody attributes of personhood, which to the West are popularly identified with the condition of 'humanity'." Opening our minds to the idea that the human/animal divide is not as wide as we generally believe provides an opportunity to investigate a more holistic view of dogs within the archaeological record.

Dogs in Archaeology

Dogs and humans have cohabitated for thousands of years, and because of this, dogs are commonly found in archaeological assemblages on every continent with human occupation. Their ubiquitous presence among human settlements on a global scale means that dogs have been studied by archaeologists all over the world (e.g. Cummings 2013; Davis and Valla 1978; Detry and Cardoso 2010; Losey 2011; Noe-Nygaard 1988; Ovodov et al. 2011). Dogs and humans are known to share foods, producing similar stable isotope ratios to one another (explored in depth in Chapter 4). Using dog remains as a proxy for human palaeodiet has become a popular way to investigate past human subsistence patterns chemically without causing physical damage to human remains. Studies have been conducted in Peru and Ecuador (Burleigh and Brothwell 1978), Newfoundland (Guiry 2012) and central British Columbia (Cannon et al. 1999), Fraser Valley (Dias 2019), and in many other locations around the world (e.g. Ames et al. 2015; Chisholm et al. 1982; McManus-Fry et al. 2016). Even though dogs are accepted, in many cases, as stand-ins for humans in archaeological interpretation, many researchers tend to classify dog remains strictly as faunal material, which is then "interpreted from implicitly 'modern western' perspectives… where animals are mindless food items, sources of tool materials, passive commodities, and status symbols" (Losey et al. 2013:90). These interpretations lack nuance, which will be explored further later in this thesis.

Dogs and humans are so close with one another that it has been argued humans would not have succeeded evolutionarily without the help of our canine companions (e.g., Shipman 2015). Dogs are found where people are, and so it is logical that they are often found in archaeological contexts all over the world, present and recorded in every continent except Antarctica[8]. Shipman

(2015) suggests that 45,000 years ago archaic human's collaboration with early dogs allowed them to take down large megafauna, like mammoths, ultimately allowing for our continuance during a period in which humans and Neandertals were dividing few available resources (Shipman 2015). Perri (2016) writes forest exploitation of the Jōmon people in Japan was only possible with the participation of dogs, because people depended on dogs specifically to hunt ungulate prey like wild boar and sika deer. Dogs were (and still are) employed as transport, in the form of dog sleds, in arctic conditions by multiple culture groups including the Inuit (Maxwell 1985; Morey and Aaris-Sorensen 2002; Perri 2016). Dogs have been essential to, and are active participants in, the human journey, creating bonds that can be seen all over the archaeological record.

The following sections highlight indications of these bonds and the closeness of the relationships between humans and dogs throughout our entangled histories. For example, the ways humans care for sick dogs, even though an ill dog can provide nothing in return, indicates a depth between species that is not seen elsewhere between domesticate/domesticator or in interspecies commensal relationships. Additionally, the inclusion of dogs in art within so many human cultures speaks to the temporal length of our relationships with dogs, the many roles that dogs have played in human society, and the importance of both of these things. Dogs are an integral part of the architecture of almost every human society, including the Coast Salish.

[8] On 17 February 1899, 75 dogs were brought to Antarctica by British expedition ship *Southern Cross*. All of the dogs survived the expedition, and dogs quickly became essential to human movement throughout and survival within the Antarctic landscape. A clause was introduced to the Antarctic treaty stating that all non-native animals must be removed from the continent, including dogs, in fear of distemper and other transmittable diseases being spread to the local seal populations. On 22 February 1994, all dogs were removed, and no dog has been back since. https://www.coolantarctica.com/Antarctica%20fact%20file/wildlife/dogs_huskies.php

Domestication of Dogs

Morey (2010) provides several definitions and characterizations of domestication from various sources over time, all of which suggest agency on the part of the human and passivity on the part of the animal, a human invention for human benefit. Two examples of these characterizations:

> The capture and taming by man of animals of a species with particular behavioural characteristics, their removal from their natural living area and breeding community, and their maintenance under controlled breeding conditions for profit (Bökönyi 1969: 219).
>
> Of all the behavioural traits that make certain animal species more attractive candidates for domestication than others (…), it is the possession of a more placid, tractable, less wary nature that is the single most important factor making certain individuals within these target species potentially more suitable domesticates (Zeder 2006: 171).

Morey (2010) argues that these characterizations are acutely lacking, and as Crockford states, "the traditional definition of domestication we have been taught to accept as fact is no more than a deeply entrenched myth (2006:40). These traditional definitions are anthropocentric, citing domestication as a human phenomenon when many forms of domestication happen in the animal world. For example, damselfish, a species common in coral reefs across the southern hemisphere, cultivate and protect their own algae gardens within the reefs (Casey et al. 2014). Leafcutter ants in South and Central America have been farming their own fungus to sustain their huge colony numbers, sometimes exceeding eight million ants, for 65 million years (Nygaard et al. 2016). In Africa and Madagascar, *Melissotarsus* ants are suggested to cultivate armoured scale insects to collect a waxy secretion produced by their pygidial glands (Ben-Dov & Fisher 2010).

These phenomena can potentially be defined in some ways as domestication, but relationships between species in which both benefit are usually referred to as mutualism (Ben-Dov and Fisher 2010) or commensalism. Traditional definitions of domestication also disregard the fact that plants and animals benefit evolutionarily from domestication more than humans do (Morey

2010). These characterizations also imply, implicitly or explicitly, that agriculture and animal husbandry are more beneficial overall than they actually are (Morey 2010). For example, Damselfish gardens are increasing the spread of black band disease in coral reefs (Casey et al. 2014), demonstrating that it is not as beneficial as it may appear for both parties.

Domestication is a process that has lacked a unanimous definition, and that definition is normally created from the perspective of the domesticator (Zeder 2015:3191). Domestication is both an environmental phenomenon and an evolutionary one (Ervynck et al. 2001); the target domesticate must adapt to its newly provided environment over several generations to be successful. Most definitions emphasize the role of humans during this process. Many also rely on rigid delineations of *wild* versus *domestic*, which are actually extreme ends of a spectrum (Ervynck et al. 2001:50) that contains generations' worth of genetic and phenotypic change. Pinpointing an exact moment in which a species becomes a 'domesticate' is impossible. A broader definition of domestication, viewing it as a long process rather than a singular event, is favourable.

Regardless of how we decide to define the process of domestication, dogs and humans have been intertwined for thousands of years. Estimates of the exact timing and locations at which dog-human domestication began are highly controversial, with genetic estimates suggesting the diversion of dogs from grey wolves happened 135, 000 years ago (Vila et al. 1997) while archaeological evidence suggests a much later timeframe of 33,000 to 15,000 years ago (Table 1) (Larson et al. 2012). Modern breeds of dog most genetically similar to wolves originated in Asia and Africa, such as the Basenji and Akita, and the most genetic diversity in dogs occurs in these areas as well (Larson et al. 2012; Perri 2014), suggesting that some of the earliest dogs originated from grey wolves in these regions.

Table 2.1: Examples of the oldest dog remains (data from Larson et al. 2012 and Perri 2014).

Site	Country	Years BP (cal.)	Confirmed Dog
Bonn-Oberkassel	Germany	14,708-13,874	Y
Palegawra Cave	Iraq	13,000	Y
Ushki I	Russia	12,900-12,600	Y
Nanguanli	Taiwan	4,800	Y
Merimde Beni-Salame	Egypt	6,800-6,520	Y
Danger Cave	United States	10,000-9,000	Y
Rosamachay	Peru	5,260-5150	Y
Chauvet Cave	France	~26,000	N
Predmosti Cave	Czech Republic	27,000-24,000	N
Razboinichya Cave	Russia	33,500-33,000	N
Goyet Cave	Belgium	31,700	N

The number of independent domestication events that have occurred is contentious, with some researchers arguing that only one major event happened (e.g., Botigue et al. 2016; Freedman et al. 2014) and others suggesting two or more events around the world (e.g. Clutten-Brock 1995; Dayan 1994). Genetic lineage of the original populations of grey wolves have not been found in living populations, suggesting that the ancestor is extinct or undiscovered (Dueleba et al. 2015; Morey and Jeger 2015; Savolainen et al. 2002; Thalmann et al. 2013). It can be difficult to discern dog remains from wolf remains morphologically in some of the oldest samples. The major defining features distinguishing dogs from wolves include a reduction in body size, a shortened muzzle with crowded teeth and a distinct angularity of the snout (Barta 2006; Perri 2014). Older samples (> 20 000 years) are much more likely to be morphologically ambiguous than recent ones (< 20 000 years) (see Table 2.1 and Figure 2.1). While evidence for the emergence of the first true dog species is still contentious, dogs have been established within many human societies for at least the past 10,000 years.

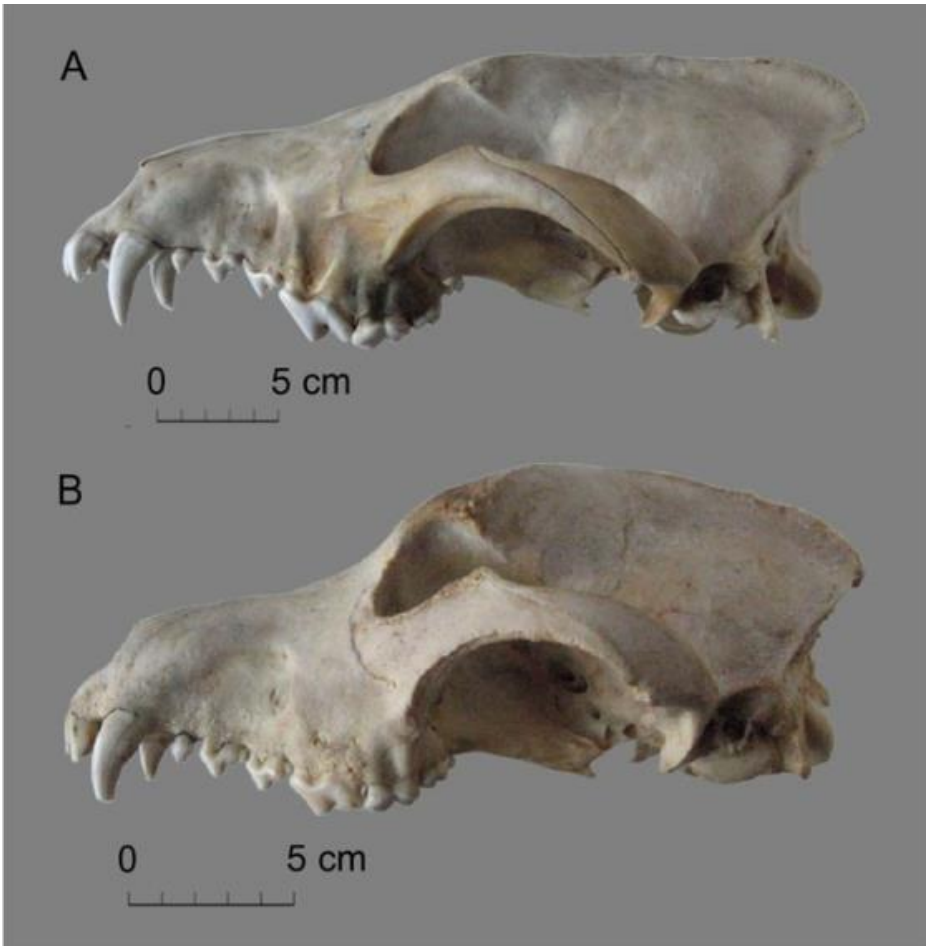

Fig. 2.1: Comparison between modern wolf skull (A) and dog skull (B) (from Perri 2014).

Healthy Dogs

The domestication and economic utilization of dogs has been explored in depth across hundreds of cultures, while the relationships between humans and dogs sometimes remains uninvestigated[9]. Most proposed motivations for the active domestication of dogs have been strictly utilitarian (see Janssens et al. 2018), disregarding the emotional and social connections between

[9] This approach has been shifting over the past few decades to produce more holistic, relational, and animistic understandings of human-animal-object relationships, particularly within Indigenous ontologies. For examples, see Bird-David (1999); Herva (2009); Hill (2013, 2018); Ingold (1986, 1996, 2000); Janssens et al. (2018); Losey (2010); Losey et al. (2011); Vandergugten (2015); Viveiros de Castro (1998).

species that go beyond economic utilization of one species by another. People cared for the health of their dogs, and this care can be recognized in the archaeological record through osteometric remains of dogs of ill health. Some dog remains in the archaeological record show signs of sickness or disease that would not likely have been survivable without assistance.

For example, over 100 years after its initial discovery in Germany, a second dog has been identified within the Bonn-Oberkassel dog remains (Janssens et al. 2018). The more recently discovered dog, dated to 14223 ± 58 years cal. BP, displays dental hypoplasia and lesions within the oral cavity, indicative of a severe canine distemper infection at the age of ~19 to 23 weeks (Janssens et al. 2018). The researchers suggest that the dog would have been materialistically useless to people during this period of infection, but the dog survived, likely indicating care on the part of a human caregiver, perhaps due to an emotional bond.

Another example of humans caring for sick dogs occurred at the Cleveland site in southern Ontario in the 16th century. Iroquoian dog remains excavated from this site presented Mycobacterium tuberculosis within its DNA, leading the dog to suffer from hypertrophic osteopathy, a form of excessive bone growth (Bathurst and Barta 2004). Tuberculosis can be transmitted between species, as dogs would scavenge for food waste within middens containing pathogens, as well as through sharing "the beds, plates, and food of their masters" (Thwaites 1896:1910). As the dog endured hypertrophic osteopathy in conjunction with tuberculosis, its limbs would have become swollen and warm to the touch, the dogs' body would become emaciated, its breathing would be laboured and it would likely have a cough. Despite the dog's decline in health and contagious nature, "not only was this animal nursed to an advanced stage of illness, it was interred with the sort of care and respect usually allotted to another human" (Bathurst and Barta 2004:922).

Tuberculosis in historic dogs from Ontario has also been discussed by Tourigny et al. (2015), who argue that an interdisciplinary approach (in this case, utilizing dietary stable isotopes in conjunction with a suite of other osteological data including medical imaging such as tomography and radiology) is necessary for gaining a greater understanding of human-dog relationships. In this study, a large dog skeleton was recovered from a 19th century burial in present-day Toronto. Researchers demonstrate through these previously listed methods that humans were providing care for the dog throughout its life, even toward the end when the dog was likely considerably ill (Tourigny et al. 2015).

MacKinnon (2010) further demonstrates the potential strength of the human-dog bond in ancient Rome by cataloging all known pathological dog remains at Italian sites within Roman contexts. Low numbers of pathologies were found overall, but the pathologies of many dogs would have required extensive care. For example, extreme calculus buildup and ante-mortem tooth loss of one dog, known as the Yasma dog, suggests that the dog would have had to be hand-fed soft foods such as ground meats by a caregiver as it would have been unable to chew hard foods properly (MacKinnon 2010). Stable isotope analysis of this dog indicates that the dog was eating a diet rich in soft meat, demonstrating "among the highest nitrogen figures recorded for dogs from Roman sites in the Mediterranean" with a δ^{15}N value of 12.5‰ (MacKinnon 2010:304). A dog with severe dental periodontitis being only fed soft, rich foods like ground muscle or organ meats will accelerate the process of dental decay (MacKinnon 2010), an unfortunate side effect of human care.

Dog Diets

Because of the closeness between humans and dogs, in both sharing a physical space and sharing emotional bonds, it is logical that the two species would share similar diets. Archaeologists have become interested in the diets of dogs because dogs can often be used as a proxy for human

remains when chemically investigating diet through stable carbon and nitrogen isotope analysis another (e.g. Cannon et al. 1999; Clutton-Brock and Noe-Nygaard 1990; Guiry 2012; Katzenberg 1989; Murray and Schoeninger 1988; Noe-Nygaard 1988; Schwarcz and Schoeninger 1991, West and France 2015). The diets of humans and dogs are so similar that the diets of humans can be inferred by their dogs. This dietary imbrication has occurred due to our physical and emotional closeness, and because our dietary obligations are similar as omnivores.

Dog palaeodiets can be assessed through stable carbon and nitrogen isotope analysis of hard tissue remains (e.g. Cannon et al. 1999; Guiry 2012; Guiry and Grimes 2013). Stable isotope ratios of carbon can distinguish between certain types of plants, while stable isotope ratios of nitrogen indicate the trophic level of the consumer (Katzenberg 2000). Combining this data provides insights into the types of foods an individual ate. Dog diets are usually different from related species in the same areas. For example, although foxes and dogs living in overlapping regions on Kodiak Island, Alaska, have similar dietary obligations, stable isotope analysis of archaeological remains demonstrates largely different diets between the two species. Foxes ate a variable diet consisting of both marine and terrestrial proteins (δ^{15}N 16.7‰ to 7.0‰; δ^{13}C -20.8‰ to -11.9‰) while dogs consistently consumed high-trophic marine proteins (δ^{15}N 14.5‰ to 17.1‰; δ^{13}C -12.9‰ to -15.4‰) (West and France 2015). This indicates dogs ate exclusively what humans fed them, in addition to what they likely scavenged themselves (West and France 2015). This dietary relationship has been indicated at other Alaskan sites as well (e.g. McManus-Fry et al. 2016) with dogs demonstrating δ^{15}N values within a range of 20.5‰-13.3‰ and δ^{13}C values within a range of -14.3‰ to -16.5‰. In addition to sharing similar skin microbiomes (Song et al. 2013), humans and dogs share remarkable similarities in gut microbiomes (Coelho et al. 2018), highlighting the long-term entanglement and sharing of spaces and foods between species.

Dogs in Art

Humans have been making art for thousands of years, which has been demonstrated at sites such as the Lascaux and Chauvet caves of southern France[10], in Altamira, Spain (Fig. 2.2(A)), and in Sulawesi, Indonesia, among others. The reasons why and whether or not art is strictly a modern human activity have been hotly debated among paleoanthropologists (e.g. Hoffmann et al. 2018) but it is usually assumed that art is not usually meaningless. The images produced by past humans or Neanderthals likely had value and significance to them, even though we do not necessarily know what those meanings are. Although depictions of dogs, or any canid, are relatively rare in Palaeolithic rock art, dogs and their close relatives have been depicted in human art in a number of ways over time. For example, Anubis, Egyptian god of the dead, is typically represented as a jackal (*Canis anthus*) or as a figure with the body of a man with the head of a jackal (Fig. 2.2(B)). Anubis escorted souls into the afterlife and decided who would be admitted into the realm of the dead. Priests would often wear masks with the likeness of Anubis when performing rituals. Dogs in Inca cultures in present-day Mexico are often presented in the artwork on ceramic vessels (Sanchez et al. 2009) (Fig. 2.2(D)), "clearly show[ing] that these dogs were symbols of divine connection and power" (Wylde 2017). In the northern regions of North America, dogs have also been depicted in Inuit and pre-Inuit art primarily through sculpture (Fig. 2.2(C)).

[10] Interestingly, Lascaux Cave was discovered by a dog named Robot. https://www.dogster.com/lifestyle/robot-the-dog

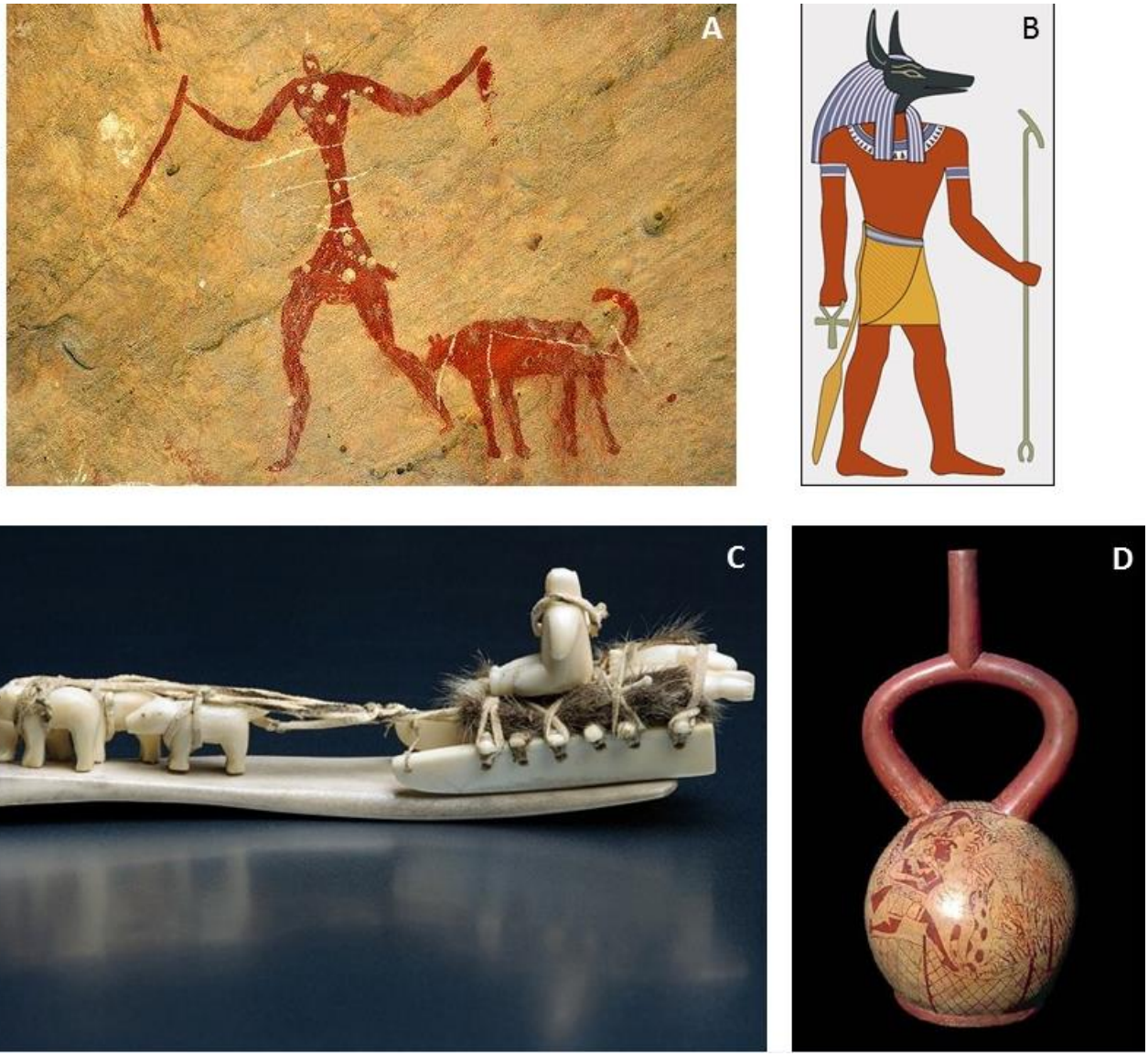

Fig. 2.2(A): Palaeolithic rock art depicting a human with a canid in Altamira, Spain[11]. **Fig. 2.2(B)**: Anubis, Egyptian god of the dead[12]. **Fig. 2.2(C):** Inuit dogsled carved from ivory, with leather and sealskin[13]. **Fig. 2.2(D)**: Deer hunt with dog depicted on an Incan vessel (Sanchez et al. 2009).

The earliest known depiction of dogs in human art is contentious. Seventh century rock art in Saudi Arabia depicting dog-assisted hunting seems to illustrate a dog that looks strikingly similar to

[11] https://blantonmuseum.org/2012/01/art-thats-gone-to-dogs/
[12] https://simple.wikipedia.org/wiki/Anubis#/media/File:Anubis_standing.jpg
[13] https://harvardmagazine.com/2011/01/good-dogs

contemporary feral Canaan pariah-dogs that still roam the region with the potential addition of symbolic leashes (Guagnin et al. 2018) (Fig. 2.3). Dogs have also been represented on ceramic vessels from two small villages in southwestern Iran as early as 8000 years ago (Hole and Wyllie 2007), and these illustrations resemble living Saluki dogs in the current region. Salukis are long, slender, agile dogs with great potential for speed. The abstract-type images discovered in Iran indicate a canid-like animal at high speed with a gait similar to the Saluki (Fig. 2.4).

Fig. 2.3: Modern Canaan pariah dogs compared to 7th century rock art in Saudi Arabia Guagnin et al. 2018).

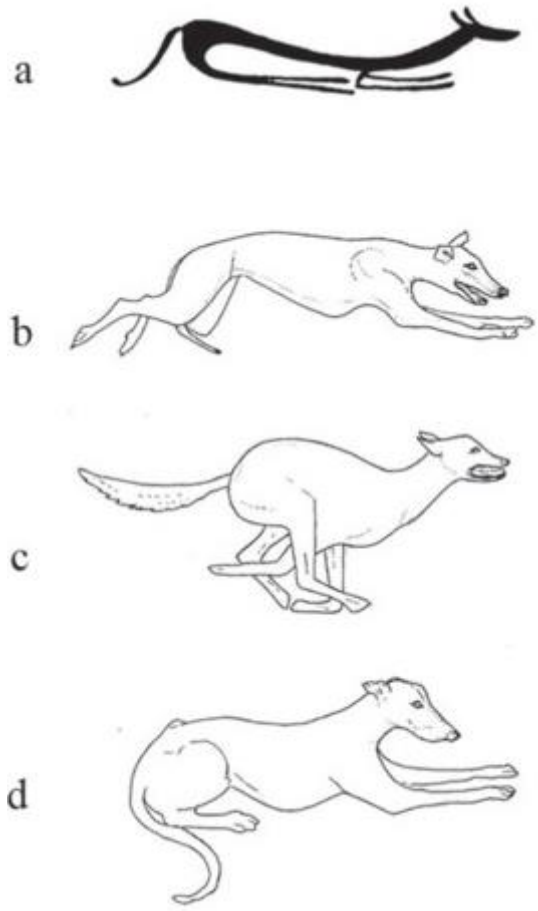

Fig. 2.4: Illustrations of modern Saluki dogs compared to a silhouette of a dog taken from a ceramic vessel, indicating a dog with a similar shape and gait to the modern Saluki (Hole and Wyllie 2007).

Dogs in Death & Dog Burials

Human burials within shell middens are common on a global scale (e.g. Bicho et al. 2010; Choy and Richards 2009; Kulatilake et al. 2014; Monks 1977). Dogs are frequently buried in shell middens either alongside their human companions or on their own (e.g., Detry and Cardoso 2010; Claassen 2017; Ikram 2013; Hill 2018; Losey et al. 2011; Marino 2015; Milner and Jeffries 1998; Monks 1977; Morey 2006). For example, dog remains excavated from a shell midden burial in 1880 have been identified in the Libson Geological Museum and dated to 7070 ± 40 cal. BP, characterizing these remains as the oldest dog remains in Portugal (Detry and Cardoso 2010). At the

Indian Knoll shell midden site in Kentucky, United States, twenty-four dog were buried with the same degree of care given to humans – thirteen of these dogs were found in context with human burials (Morey 2010), suggesting that they were considered to carry enough social importance to be buried alongside humans.

Dogs are also often found buried in spaces presumed to be reserved for human remains. Two 7,000-year-old dog skeletons were buried with mortuary treatments typically reserved for humans in the earliest known cemeteries in Cis-Baikal, Siberia (Losey et al. 2011). Two wolves were also afforded human-like mortuary treatment; though stable isotope analysis of both dog and wolf diets differ between species (Losey et al. 2011). The dog appeared to be consuming primarily high-trophic marine foods provisioned by humans, while the wolves' diet is more consistent with the consumption of terrestrial ungulates (Wolf isotope values = δ^{15}N 16.2‰, δ^{13}C -20.2‰; Dog isotope values = δ^{15}N 16.6‰, δ^{13}C -16.1‰) (Losey et al. 2011). In Canada, dogs have been found buried with human remains in Rattler's Bight, Labrador (Fitzhugh 1976; Harris 2019, pers. comm.), and at Port au Choix-3, Newfoundland (Harris 2016; Tuck 1976), again suggesting that dogs and humans were bonded closely enough in life to warrant a close burial.

Dogs in ancient Egypt were commonly mummified prior to burial (Huchet et al. 2013; Wapnish and Hesse 1993) (Fig. 2.5). The catacombs of Anubis, ancient Egyptian protector of the gates to the underworld, contain the mummified remains of over eight million animals, most of them dogs (Nicholson et al. 2015). Many were purposefully mummified by humans, while the large number of neonates present were likely either killed or left to starve, becoming naturally desiccated within the cool, dry catacombs (Nicholson et al. 2015). Mummified dog remains can provide information that is otherwise lost in the decomposition process, such as the presence of parasites such as lice and ticks (Huchet et al. 2013). Many of these parasites can be passed between people

and dogs or from food to individual consumer, indicating close living quarters and shared diets between the two species. On the northeastern region of the Iberian Peninsula, 26 dog burials in association with human remains from four archaeological sites emphasize the relationships between humans and dogs 4000 years ago (Albizuri et al 2019). Stable carbon and nitrogen isotope analysis of these dog remains indicate that the dogs were consuming a mixed diet including terrestrial plant material and herbivory animal. Researchers found that $\delta^{13}C$ data demonstrated a range of -22.2‰ to -19.4‰, and $\delta^{15}N$ data demonstrated a range of 4.2‰ to 9.2‰, reflecting similarities between human and dog diets. When combined with funerary data, this study suggests a close relationship between the two species (Albizuri et al. 2019).

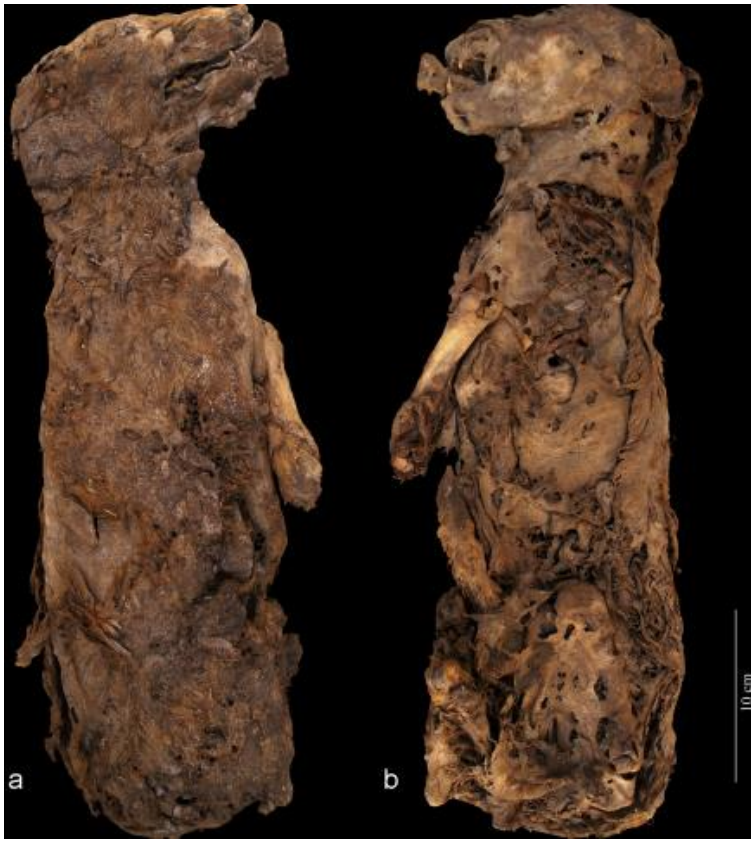

Fig. 2.5: An intentionally mummified Egyptian dog (from Hutchet et al. 2013).

In British Columbia, dogs are found buried in shell middens, either with or without accompanying human remains (e.g. Barnett 1955; Cannon et al 1999; Cybulski 1992; Digance 1986; Marino 2015; Monks 1977; Suttles 1974). Shell middens, sometimes of massive proportions (Stein 1992), are dynamic features prevalent on the coastal landscapes of British Columbia. They are diverse human-made cultural features created primarily from discarded shell and often contain cultural material, found globally in a wide range of oceanic and freshwater coastal environments (e.g. Alvarez et al. 2011; Bicho et al. 2010; Classen 1991; Milner et al. 2007; Moss 1993).

The complexity of shell middens renders them difficult to excavate. Researchers often prefer use coring/auguring methods of data collection (e.g. Cannon 2000) to preserve stratigraphy while minimally disturbing the sample (Stein 1986). Although individual bones may be retrieved, burials cannot be seen through coring or auguring. The dog remains that have been excavated from coastal archaeological sites in B.C. were primarily excavated several decades ago and often have very little mortuary context left in connection with them. However, even though mortuary contexts may be unavailable, studying the diet of individuals of both humans and dogs can reveal these relationships. Sharing temporal and spatial spheres with one another also involves the sharing of resources, including food. Humans in B.C. consumed primarily high-trophic marine diets including marine mammals and fish (e.g., Cannon et al. 1999; Chisholm et al. 1982; Diaz 2019; Schwarcz et al. 2014), and by proxy so did their dogs (e.g. Cannon et al. 1999; Guiry 2012).

CHAPTER 3: Dogs in British Columbia

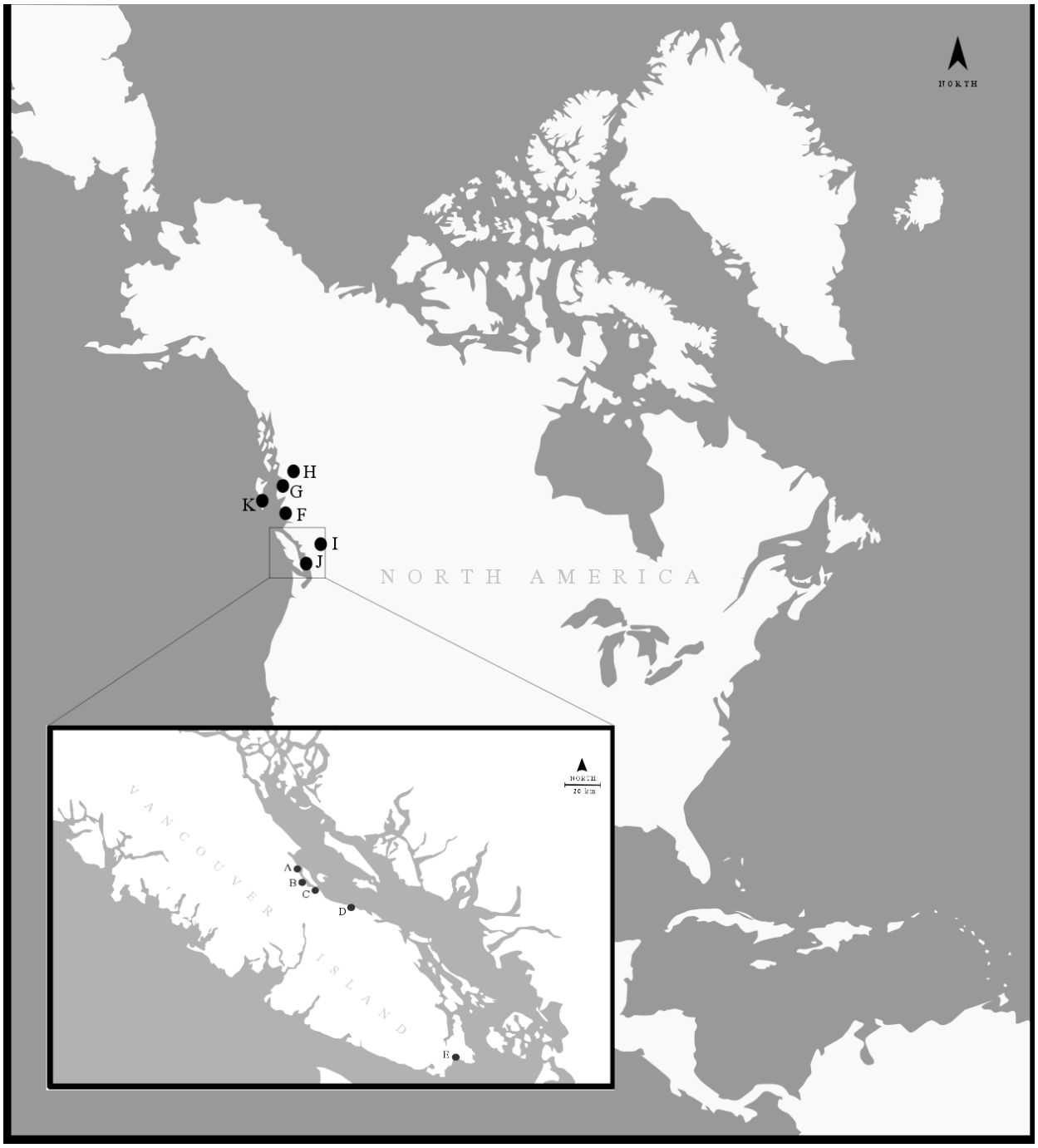

Fig. 3.1: Map of study sites. **Inset**: (**A**) Buckley Bay (DjSf-13) & Tsable River (DjSf-14); (**B**) Ship's Point (DjSe-6); (**C**) Deep Bay (DiSe-7); (**D**) Little Qualicum (DiSc-1); and (**E**) Maple Bank (DcRu-12). **Other sites of note**: (**F**) Namu (ElSx-1); (**G**) Boardwalk (GbTo-31); (**H**) Greenville, (**I**) Keatley Creek (EeRi-7); (**J**) Dionisio Point; and (**K**) Haida Gwaii.

Origins of North American Dogs

Recent sequencing of ancient North American and Siberian dog mitochondrial genomes suggest that modern North American dogs did not evolve from North American grey wolves, instead originating in Siberia and dispersing throughout North America with the movement of human populations (Leathlobhair et al. 2018). Seventy-one mitochondrial and seven nuclear genomes from ancient Siberian and North American dogs spanning approximately 9000 years were sequenced. Results indicate that this monophyletic lineage of dogs was almost entirely eradicated with the arrival of Europeans (Leathlobhair et al. 2018).

Archaeological Dogs from the North and Central Coasts of British Columbia

Dog remains recovered from archaeological sites are more frequently becoming the main subject of archaeological research. Since dogs have been shown to be reliable proxies for humans when investigating palaeodiet (e.g., Cannon 1999), archaeologists studying palaeodiet can utilize dog remains (often in lieu of but sometimes in addition to human remains) for stable isotope analysis. Cannon et al. (1999) published isotopic dietary data of 15 dogs from Namu (ElSx-1), in the territory of the Heiltsuk First Nation, to investigate human subsistence trends that were previously inferred through faunal analysis. Their results indicate temporal variation in the consumption of marine species, specifically an increase in dietary variability between 3500-1405 BP, during a period ranging from 6060-1405 BP. $\delta^{13}C$ values exhibit less variability overall (ranging from -12.2‰ to -14.4‰), while $\delta^{15}N$ values show a consistent decrease over time (17.3‰ to 14.8‰) (Cannon et al. 1999:403). The dog's $\delta^{13}C$ values matched known human values for the site (Cannon et al. 1990:405), while $\delta^{15}N$ were predictably lower than human values, and demonstrated dietary variability that correlates with analysed faunal remains (Cannon et al. 1990:405). They suggest that

similar studies of dog remains would be valuable to understanding variability within Northwest coast subsistence economies.

The Canadian Museum of History features a history of the excavation of the Boardwalk site (GbTo-31) in Prince Rupert Harbour. These are the results of the North Coast Prehistory Project (NCPP). One dog burial was discovered at this site, and the museum provides this information alongside an image of the dog in-situ:

> When a chief died, the villagers chose a dog that would be possessed by the chief's soul. The soul wandered throughout the heavens for several years, but when it returned to visit the village, it inhabited the body of a dog. Everyone in the village knew that particular dog was carrying the chief's soul. When the dog died, it was given the same burial that a human would receive[14].

This particular passage and the presence of dogs within the context of human burials suggests again that individual dogs held potentially significant, ambiguous social positions.

Archaeological Dogs from the Fraser River and Interior

The diet and significance of dogs has been explored at the Keatley Creek Village Site (EeRi-7) in the Mid-Fraser River area of British Columbia by Crellin in 1994 (Crellin 1994), who suggests that dogs held large social and economic roles within Interior Salish groups, particularly within societies of those with close relationships to Coast Salish groups. These results are based on in-situ analysis of 12 dog burials, osteological analysis, coprolite, and isotope data. Isotope data for this project was obtained through stable carbon isotope analysis, indicating, "up to 75% of their protein intake came from marine sources" (Crellin 1994:230); no $\delta^{13}C$ values are reported. Several well-preserved dog coprolites were recovered from the site; again, the specific number of coprolites was not reported. These coprolites contained salmon bones and mammal bone, which Crellin suggests

[14] https://www.historymuseum.ca/cmc/exhibitions/aborig/tsimsian/arcdogbe.html

resembles dog bone. A diet isotopically high in marine protein for an interior dog could be due to dogs consuming human feces, or from trade of marine resources with Coast Salish groups.

Dogs have also been found in association with human burials as well as within their own discrete burials at sites in Interior British Columbia (e.g. Cybulski 1992; Digance 1986; Suttles 1987). Also at Keatley Creek, the remains of three dogs were recovered from graves lined with grass and birch bark (Digance 1986). This treatment is identical to the treatment afforded to human remains at the site (Digance 1986). While this is an over-simplified interpretation of mortuary practices, the overall implication is that the dogs held at least some meaning to those who buried them.

Coast Salish Dogs

When archaeologists write about Coast Salish dogs, they are usually talking about a specific 'type' of dog, known as a wool dog. It is argued that the Coast Salish actively bred small Pomeranian-type dogs with long coats and vulpine faces (Anderson 1840, in Keddie 1993; Ashwell 1978; Barnett 1955; Crockford 1997; Elmendorf and Kroeber 1992; Amoss 1984; Suttles 1951). The Salish wool dog is considered by some to be one of the first true dog breeds in North America (Crockford 1997).

In addition to wool dogs, the Coast Salish are also considered to have maintained a mutt-like dog, known as a village dog or hunting dog (Crockford 1997). This dog is not well described ethnographically but may be potentially distinguishable from wool dogs through osteometric data, as it is thought to have stood several centimetres taller on average than the wool dog (Crockford 1997). Village dogs had short fur and resembled coyotes in stature. Both wool dogs and village dogs were bred as hunting companions, as a resource, and as a source of wealth (Barnett 1955).

Osteometric site-specific studies of dog remains within the Coast Salish have been conducted by Crockford (1997), Digance (1986), Gleeson (1970), and Montgomery (1979), mainly to test the potential to identify the presence of 'wool dogs'. The most recent and comprehensive is Crockford's (1997) project, which analyzed 1163 cranial and post-cranial dog remains from 21 archaeological sites associated with the Coast Salish. Results suggest there was a mean (9%) difference in size between the two types, with smaller dogs measuring approximately 44 cm at the shoulder compared to 52 cm for large dogs. This is too large of a difference to be sexual dimorphism, which normally accounts for a 2-6% difference in size in wild canids, indicating that the wool dog could be labelled a true breed (Crockford 1997). The remains from Crockford's study have been relationally dated to as early as 4000 BP, with the most recent being approximately 500 years old. These remains constitute only a small subset of all the archaeological adult dog remains found from these sites (Crockford 1997).

The results of Crockford's study strongly suggest the presence of two sizes of dog, from which the presence of a specific breed can be extrapolated. The strongest evidence includes the difference in sex ratios within cranium and mandible samples of the two types, suggesting that the small dogs were being deliberately bred, constituting a true breed. In contrast, the village dog likely does not constitute a true breed - while effort would have been exerted in keeping breeding female wool dogs separate from male village dogs, less effort would be taken in keeping male wool dogs away from female village dogs, accounting for the increased heterogeneity in the osteological samples characterized as village dogs. Barsh et al. (2002) also suggest that there could be a distinction between purebred hunting dogs, purebred wool dogs, and the village dog, with the village dog considered a mixed-breed between the two, but it is difficult to determine with any certainty without any existing type specimens.

In addition to osteological data, genetic data from Coast Salish dogs has been studied as well. Barta (2006) identified a coyote mitochondrial haplotype within the DNA of Northwest Coast dog populations, including at Coast Salish site Dionisio Point. This unexpected result indicates that people had "access to canids that possessed coyote mitochondrial signatures, [though] it is unclear whether this represents the domestication of actual coyotes present in the region, wolves that had hybridized with coyotes, or a long-distance acquisition of unique wild canids or dog hybrids through travel and/or trade" (Barta 2006:107-8). The coyote's pre-contact range is suspected to have been limited in northern regions by the grey wolf, with a northward expansion occurring within the last century (Parker 1995).

There is no other archaeological evidence of coyote in this region, however, very little has been excavated overall in terms of the vast size of the region, and the animal remains recovered from archaeological contexts are often fragmented and lack distinctive morphometric features (Barta 2006). Although the genetic origins of dogs in this region are not necessarily conclusive, Barta's research demonstrates that this haplotype was maintained over a 3000-year, 600-kilometre span of time and space (Barta 2006).

No images of either the wool dog nor the village dog exist today, although artist Paul Kane painted an image of what is thought to be a wool dog around 1810 (Fig. 3.2). This image is not usually considered an accurate representation because it looks quite lamb-like rather than like a canid (Crockford 1997). However, ethnohistoric records often cite the dogs looking like shorn sheep (MacLachlan 1998; Lamb 1984). The sketches Kane created prior to the painting are regarded as a more faithful representation (Fig. 3.2). Additionally, Crockford (1997) employed forensic artist of the Royal Canadian Mounted Police Cpl. Pye to create composite drawings of both wool and hunting dogs based on morphological measurements, ethnohistoric data, and physical crania (Fig.

3.3). These images incorporate a fair amount of artistic license, but are likely some of the more accurate representations available.

Fig. 3.2: Woman weaving. Paul Kane ~1810.

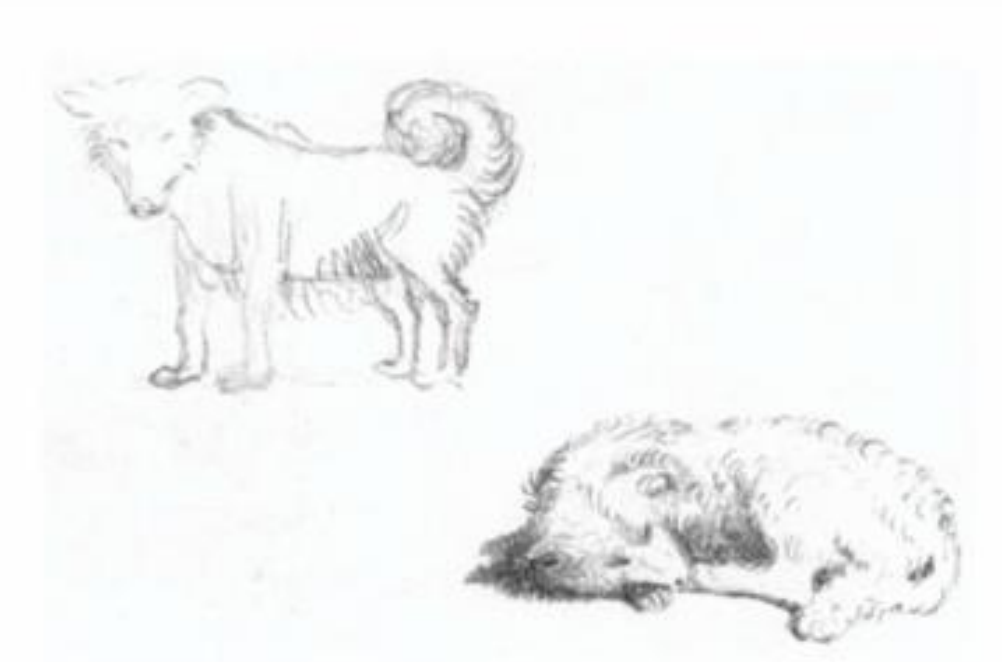

Fig. 3.3: Untitled sketch. Paul Kane ~1810

Fig. 3.4: Artist's interpretation of a village dog (left) and wool dogs (right) (Crockford 1997).

Wool Dog Blankets

Both isotopic analysis (Schulting 1994) and light and scanning electron microscopy[15] (Humphrey and Loychuk 2018) have confirmed the presence of dog hair within traditional Coast Salish woven blankets (Fig. 3.5). Dog wool could be mixed with goat wool, waterfowl down, fireweed cotton or other plant material to be woven into large blankets (Ashwell 1978, Barnett 1955, Keddie 1993, Turner and Bell 1971). Grease and staining were removed using clay beaten into the wool with a flat piece of wood. The weaver would comb the fibers out flat and roll them out to prepare them for spinning. The wool would be made into a yarn using a tall wooden spindle, and would then be woven into blankets on a loom. Colourants were rarely used in the yarn until the arrival of European settlers, but dyes were made using alder bark, lichen, cedar and hemlock bark, Oregon grape, and copper (Ashwell 1978). The fur of the wool dog was ideally white in colour, but could range from light to a brownish-black (Ashwell 1978). With the advent of the Hudson's Bay Company and the distribution of factory-made wool blankets in large quantities, the need for blankets made of dog wool disappeared. Wool dogs have long since interbred with village dogs and the pets of European settlers during colonisation and are now phenotypically extinct (Schulting 1994).

[15] https://salishseasentinel.ca/2017/07/a-tale-of-two-coast-salish-blankets/

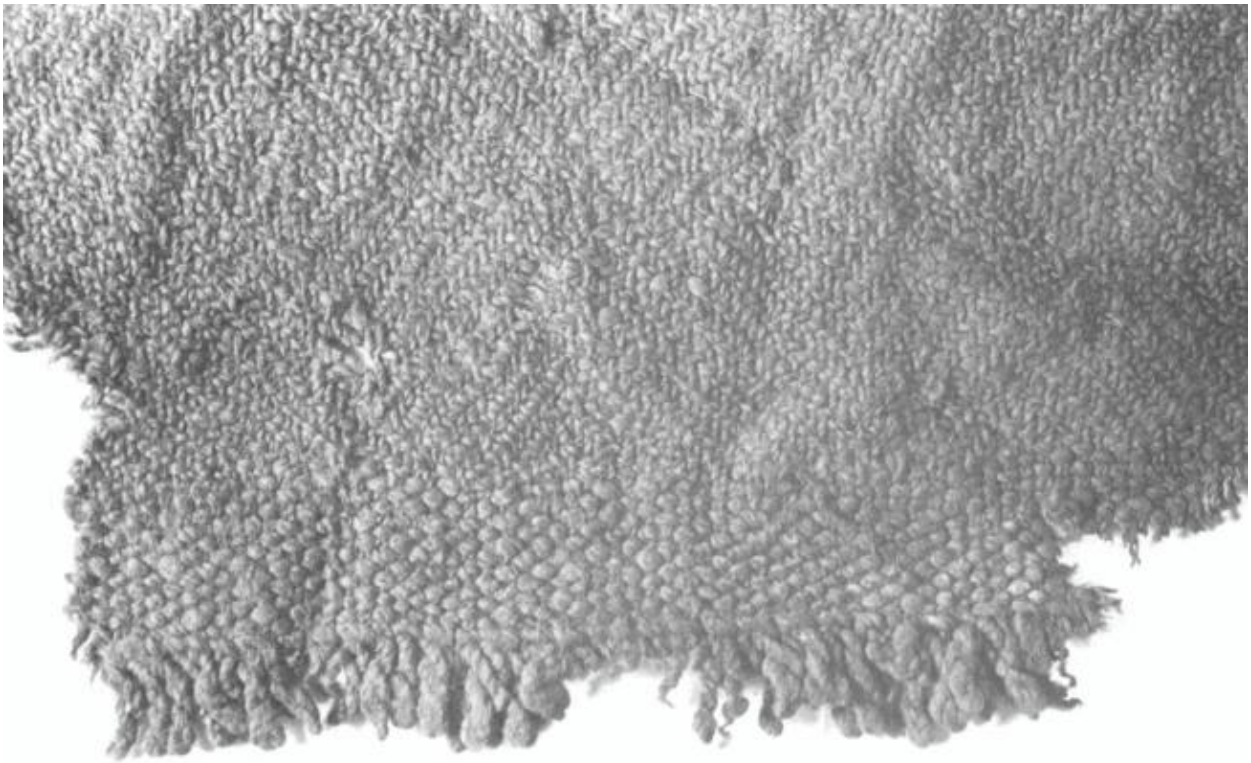

Fig. 3.5: Detail of Yale blanket, containing Coast Salish dog hair (Schulting 1994).

Coast Salish Dogs in Ethnography

Suttles (1951) conducted comprehensive interviews with Salish peoples from the Northern Straits and learned only one generic word for dog, sqéx̌ə, although he heard descriptions of two distinct types of dog (Barsh et al. 2002). The Twana Salish of Puget Sound normally referred to both kinds as sqʷəbáy, although occasionally specified one as being longhaired, or šiʔášʔalqaʔd (Elmendorf 1992; Barsh et al. 2002). Barsh et al. (2002) suggests that this linguistic limitation indicates that there was little morphological difference between the two dog types other than the length and quality of their coats.

Ethnographic evidence suggests that dog diets were controlled, with wool dogs generally being fed a diet of dried fish until the first spring shearing (Barnett 1955). Hunting dogs were fed scraps of meat, with bones removed to protect their teeth (Barnett 1955). Normally, deer meat was

used as it was thought to familiarize the dog with their prey (Elmendorf and Kroeber 1992; Barnett 1955). Hunting dogs were also fed unusual mixtures of food during their training, similar to the concoctions put on their noses to enhance their senses, such as combinations of deer urine, crushed buzzard heads and feathers, and wild onions, among other things (Barnett 1955). These dogs were highly trained to locate and herd game animals. Deer would be driven into lakes or streams by the dogs, where people in canoes waited to kill them, or into open fields where they could be shot with arrows (Barnett 1955). The dogs were also often trained to track bears (Barnett 1955).

Subsistence

The Coast Salish primarily fished, hunted, and gathered a variety of species found on Vancouver Island and the mainland. Seal was the most important animal hunted by the Coast Salish (Barnett 1955:95), and deer, elk, bear, raccoon, porpoise, grouse, and waterfowl were all regularly hunted for their meat (Barnett 1955). River otters, minks, and martens were hunted for their pelts rather than for their meat (Suttles 1951). Salmon, herring, halibut, and cod were caught using specialized fishing equipment made from plant material (Barnett 1955). Although plant material was utilized in many ways (e.g. fishing and hunting equipment, utensils for eating and for food preparation, instruments, and tools, among many others), plant foods accounted for very little in the overall diet but included blackberries, salal berries, soapberries, and blackcaps (Suttles 1951). Clams, specifically horse and butter clams, were available year-round at low tide and were considered a staple food item (Barnett 1955). Other shellfish consumed include blue mussel, native oysters, chitons, whelks, crabs, and urchins (Barnett 1955).

Evidence for the Consumption of Dog Meat

Although dogs were likely considered a source of food for some groups in the Interior region of British Columbia (e.g., Crellin 1994), dogs in Coast Salish society were not eaten (Barnett

1939:277; Crockford 1997; Elmendorf and Kroeber 1992; Marino 2015) outside of possible ritual consumption (discussed further in the next section). Dog remains recovered from the Dionisio Point site demonstrate exceptionally low rates of cutting and burning, indicating that these dogs were not raised for consumption (Marino 2015), although the presence of cut marks on joints and on the crania of some dogs suggests that they were processed post-mortem (Crellin 1994; Marino 2015). Marino (2015) suggests that young dogs may have been culled, their fur used as low-status clothing, or they may have been sacrificed to augment the burial of an associated human child. A dog mandible from Pender Island Canal site DeRt-2 does demonstrate evidence of skinning (Digance 1987, Hanson 1991:188), although dog bones from neighbouring site DeRt-1 show no cuts or marks.

Dog Eater Dance

Dogs had the potential to act as metaphorically human in rituals, such as in the Dog Eater Dance. The dance is a performance in which an initiate would become possessed by the village's guardian spirit and would devour dogs in a frenzy while dressed in wolf skins (Amoss 1984; Crellin 1994). It is unclear if dogs were actually consumed during these rituals or if it was a symbolic gesture, but the uninitiated were meant to believe that, they were in fact, eating a dog alive (McIlwraith 1948, Amoss 1984, Crellin 1994). The Dog Eater Dance has many parallels with other 'cannibal dances' in their practice (Crellin 1984), in that it is performed in much the same way, except a recently deceased corpse or living person is substituted for the dog. It is said that the first Dog Eater received their power and the dance from wolves (McIlwraith 1948), who are predators of dogs. When a Dog Eater, inspired by the spirit of the wolf, eats a dog, he can be viewed as a cannibal from two perspectives: as a human eating an animal symbolically equated with being

human, or as a wolf eating his brother (Amoss 1984). Marino (2015) suggests that consumption of dog was ritualized behaviour, which was not socially acceptable outside of this culturally approved instance, as it was considered the behaviour of a mad person or a cannibal.

Dogs in Coast Salish Traditional Narratives

No other species has aligned itself with humans in such the way that dogs have (Whitridge 2017). Dogs and humans are each their own agents, but are permeable beings that are mutually constitutive with each other, allowing each species to grow and evolve through constant social, emotional, and spiritual exchange. According to various traditional Coast Salish narratives, dogs occupied a liminal space between human and animal. The question of personhood can be investigated more closely in this context, as personhood is dependent upon a being's relationship with other beings. Any animal could potentially act as a person, but the long-term cohabitation and entanglement of dogs and humans creates a unique circumstance.

How Dog came to Live with People

Dogs are present in several Coast Salish traditional narratives, and these narratives often represent the symbolic significance of dogs within human society. For example, the story of how dogs came to live with humans demonstrates the liminal position held by dogs and their dual alliance to both culture, represented by fire and cooked food, and nature, represented by their sibling relationship to Wolf and Coyote (Amoss 1984). Dogs in this narrative serve as a symbol of mediation.

> Wolf, Coyote, and Dog were brothers. They were hunters. They kept their campfire burning all the time. One day they were so busy eating the meat they had caught that they forgot to watch their fire. "Why don't you fix the fire?" Wolf asked. "Oh, I have no time," one of the others said. By the time they had finished, their fire was out. Then one said, "which one of us is going to go to the people and ask them for some fire?" "Well, I can go. I'll ask

> them to give us some fire," Dog said. "All right," his brothers said, glad to let him go. Dog went to the people to ask them for the fire. They had some food. "We'll give you something to eat. Stay with us," they said and placed some food in his palm. He never went home. Today, one can see a cushion at the base of his palm, where they placed the food. He stayed there for good. His brothers are still angry with him because he never returned. When Wolf and Coyote meet Dog, they always fight him. (Adamson 2009)

In addition to acting as an intermediary character, Amoss (1984:297) argues that dogs can act as symbols for human actors in ambiguous relationships, "just as the dog's perplexing status is a conceptual problem, the arrangements among human beings which muddle categories that should be kept distinct also pose a problem. Paramount among such irregular relationships are incest and cannibalism." Levi-Strauss argues that cannibalism and incest are conceptually related because they both use an unsuitably close object instead of an appropriately distant one in these situations (Levi-Strauss 1990, Amoss 1984). While there is no archaeological evidence for cannibalism or incest, dogs are often featured metaphorically in Coast Salish narratives and rituals, which touch on these points.

Dog Husband Story

One of these narratives is called the Dog Husband story:

> The daughter of a high-class family has an unidentified lover who only comes to her after dark, and does not speak. She becomes pregnant and delivers a litter of puppies – the number of puppies vary, but normally there are three or four males, plus one female who is half-human and half-dog. The woman's relatives, disgusted with her, pack up everything and leave her with no provisions or tools to die with her offspring. One individual (normally a grandmother or uncle, sometimes a slave) pities her and leaves coals behind so she can rekindle the fire. The woman forages and makes a shelter for her and her puppies. When she is out collecting food, she hears singing from the shelter. Her male puppies shed their dog skins, then dance and sing in human form while the mother is away, while their sister watches for their mother

> from the door as a sentinel. The mother becomes suspicious of these sounds and secretly comes back to the shelter, catching the sons in human form. She angrily throws the dog skins into the fire and reprimands them for deceiving her while she works so hard to feed them. The sons, remorseful, become proficient in skills of hunting, fishing, canoe building, and whaling, among others. The sons become almost superhuman in their abilities. One of the original relatives sees smoke rising from her house and returns to investigate, finding the house stuffed to the brim with dried smoked meats and other foods. In some versions, the woman reconciles with her family, in others she is implacable and destroys them all, except her benefactor who left the fire (Amoss 1984).

The Dog Husband story illustrates the idea of an inappropriate relationship, and Amoss (1984) argues that in this case the dog represents a close relative with whom sexual relations are forbidden. Levi-Strauss (1990) identifies this narrative as a transformation of brother-sister incest myths. The lesson of the story is less important in this context than the significance of the role of the dog, who is considered an ambiguous enough character in Coast Salish culture to be a symbolically human.

The Boy Who Turned into a Dog

This narrative emphasizes the importance of the treatment of dogs. The story of the boy who turned into a dog describes a boy who frequently mistreated his dog. The dog quickly became tired of the abuse. The dog gathered a group of village dogs together for a meeting, at which they decided the boy should be punished. They transform the boy into a dog. The boy lived among the dogs until one day he was bathing in human form after removing his dog skin, and a man from the village found him and took him back to his family. The boy continued to eat scraps and garbage for some time after that (Marino 2015). This narrative also repeats the idea of transformation present in the Dog Husband story.

Transformation of Coast Salish Dogs

Transformation plays an important role in Coast Salish ancestry, as it is believed that living people are descended from people in the past who had the power to transform to and from animal states (Hill-Tout 1978). This has implications for the power of animals today, who are not just regarded as a resource but instead like an ancestor (McHalsie 2007). Thom (2005:77) writes, "In Coast Salish culture, oral traditions about the First Ancestors of local communities and the mythic journeys of the Transformer who travelled the land, provide some of the basic cultural material by which people develop and express their relationship to the land". This can be extended to express the relationship between people and animals, and in this case, the relationship between people and dogs.

As demonstrated through narratives, dogs had the ability to occupy social roles reserved for humans. From an economic standpoint, some dogs were bestowed with inherited ancestral names and wealth. A dog became chief by inheriting the position from a childless family (Switzer 1992) in at least one case. Men in debt to their wives' family could ceremonially marry a family's favourite dog as a 'bride' in order to return some of his acquired names to her relatives (Switzer 1992), but only certain dogs were considered worthy of acquiring ancestral names (McIlwraith 1948). Socially, rules for naming humans also extended to naming dogs, although dogs were not given human-specific names (Barnett 1955; Elmendorf and Kroeber 1992). Names given to dogs did not need to be validated, but no two dogs could be given the same name at the same time, following the same rules as naming a human (McIlwraith 1948). Slavery was a common practice among many Pacific Northwest cultures, and dogs could act as an appropriate stand-in for slaves in certain contexts because of their similarly ambiguous status as persons (Donald 1997). Amoss (1984) suggests that the dogs used as sentinels and for hunting were more adept at communicating with humans, and

thus were viewed as closer to human than many wool dogs, which may have been viewed more as a type of livestock.

Transformation is an important concept within this context. Creation narratives in Coast Salish history describe humans coming from human ancestors, but these ancestors had the ability to transform into and from animal form at will through the donning and removal of skins (Marino 2015; McIlwraith 1948; Hill-Tout 1978). Both animals and humans come from the same ancestry, of humanity rather than animalism, where animals maintained the same mental competence as humans in addition to the ability to transform. The agency of animals remained equivalent to the agency of humans throughout ancestral transformations, remaining parallel throughout history.

The Ambiguity of Coast Salish Dogs

It is argued that instead of viewing the world as dichotomous, the Coast Salish lived within a world populated by different types of beings. In this context, dogs did not straddle two worlds, but instead lived more closely with humans than any other animal (Marino 2015). Instead of an assumed duality between nature and culture, as per traditional Western belief, indigenous Salish ontology does not delineate between these worlds. There is no distinction between real, mythical, or supernatural beings; instead, everything exists within the same world on one spectrum of reality (Marino 2015). All animals have the potential to engage as non-human persons, but dogs particularly fulfill this role due to their social nature and their habitation within human settlements (Marino 2015). Beings can live social lives in parallel to humans, and certain beings even exist as humans until interaction with humans occur, at which time they can change form. The physical appearance of a being does not specify social boundaries, but humans interact socially with all beings within their world (Losey et al 2011, Marino 2015). Ingold (1994:18) writes “humans and

animals are understood as fellow inhabitants of the same world, engaging with one another not in mind or body alone but as undivided venters of intention and action, as whole beings."

In southern Coast Salish groups, it has been quoted that dogs are so close to man that there is a risk of the line between them being effaced (Elmendorf and Kroeber 1992). Because dogs occupied a liminal space between personhood and the animal world, they could identify other nefarious beings that also occupied this space, like witches, and ghosts of the recently dead (Amoss 1984). Dogs were noted to have the ability to recognize liminal spirits and warn the living against them. Because of this ability, dogs often acted as spirit helpers of shamans. Land otters were another highly ambiguous being, and were often considered people who had drowned and suffered a change into aquatic men (Amoss 1984). They could take the form of humans, mimicking a person's close relative, and attempt to deceive people into following them. No matter how cleverly otters were disguised, however, dogs were never fooled (de Laguna 1972).

Death and Burials of Coast Salish Dogs

In death and burial, dogs were often considered human analogues. Shamans could harness dangerous powers from the corpse of a dog, because they were functionally equivalent to the bodies of humans (Crellin 1994, Amoss 1984). One of Amoss' informants states that "you can't keep a dead dog in your possession or they will tie you up for witchcraft - a rotting dog is stronger than a dead person" (1984:295). The treatment of dogs in death mimics that of humans in that only some dogs are afforded formal burials and these typically appear the same as human burials in the archaeological record (Marino 2015). Within a relational animistic framework, dogs had an increased potential to operate as a person because of their frequent interaction with humans (Losey et al. 2011, Marino 2015). These engagements construct an identity of personhood within Coast Salish society, and this is visible in burial of dogs within human cemeteries (Marino 2015).

The social significance of 12 dog burials within a single-site context from the Parry Lagoon midden on Dioniso point, Galiano Island in the Salish Sea was analysed by Marino (2015). A burial is defined as the skeletal elements of one or more dogs, clearly in association with a burial pit. The results suggest that humans were actively managing breeding populations of dogs, that they were not being maintained for consumption, and that they were well cared for and their health was well maintained. The approximate ages of death suggest that animals with unfavourable traits were culled before the age of two as an intensification of management practices. Theoretically, it is interesting that puppies were buried intentionally, as they presumably would not have had the same amount of time to build relationships with humans as an older dog would. Marino suggests that the culling and subsequent burials may have been ritualistic with practical reasoning, or they may have acted as a form of accompaniment to a human child who is buried just below them, although this is not as likely (Marino 2015). The dogs in this sample did not show any pathologies associated with human mistreatment of animals, aside from one lone vertebral fracture, which had healed long before death. This suggests that the dog was provided with some level of care after the injury, as it would likely have had mobility issues. The injury may have occurred through mistreatment, but more likely would have been the result of an accident or encounter with a large wild animal.

While some inland Northwest Coast groups maintained dog populations for consumption, the very low rate of cutting (1.34%) and burning (0.34%) of the Dioniso Point remains, as well as a lack of long bone breakage for marrow extraction, indicate that these dogs were not consumed. Instead, Marino suggests that some dogs may have been processed post-mortem for various reasons, including the use of dog skins as clothing or quivers. Dental anomalies, such as tooth agenesis and alveolar bone recession, within this population suggest that the dogs were fed human-controlled soft diets and demonstrate evidence of population maintenance through human involvement, rather than

indicating poor nutrition (Marino 2015). The dogs in this sample appeared in organized burials within a human cemetery, in general or direct association with human remains. Two out of five burials had a significant number of artifacts included within it, including worked bone, whole bifaces, polished bone, and ground stone beads. The change in characteristics of the dog burials over a temporal scale match the change in characteristics of human burials over the same period.

The sample from Dioniso Point demonstrates that dog burials mimic human burials within shell middens, and that dog mortuary traditions shift temporally to match human mortuary traditions. However, while some dogs were afforded this type of care in death, some dogs appear to have been simply tossed onto the midden. This suggests that, although they had the potential to be ontologically considered persons, those dogs did not have the same relationships with humans as the formally buried dogs. Their personhood was contingent upon their engagement with humans, as per the framework of relational animism. Marino's data demonstrates that dogs were treated well and maintained with care, and certain dogs obtained status as non-human persons and were treated as such in death. Archaeological data combined with traditional Coast Salish narratives support the closeness in relationship between humans and dogs, the long history between humans and dogs, and dog's position as an ambiguous figure. Dogs can act as metaphors within these narratives and rituals for humans, becoming representative of a person while remaining physiologically something else.

Although Coast Salish dogs have interested archaeologists in the past, much of the focus of previous research has been confirming whether wool dogs existed as a specific type or breed of dog. Other than these circumstances, dog remains associated with the Coast Salish are generally mentioned within faunal reports of site analyses rather than being at the focus of research. However, recent research focusing on Coast Salish dogs in other contexts include Marino (2015) and Diaz (2019). Marino (2015) analysed dog burials from Dionisio Point using relational theory to

understand the ontological significance of dogs and people. Diaz (2019) also uses relational theory in conjunction with stable carbon, nitrogen, and sulfur isotope analyses of dogs and other mammals to investigate relationships and foodways between people of the coast and those of the interior. These studies veer away from identifying a specific type of dog, instead choosing to focus on relationships between species and the environment in a more holistic way.

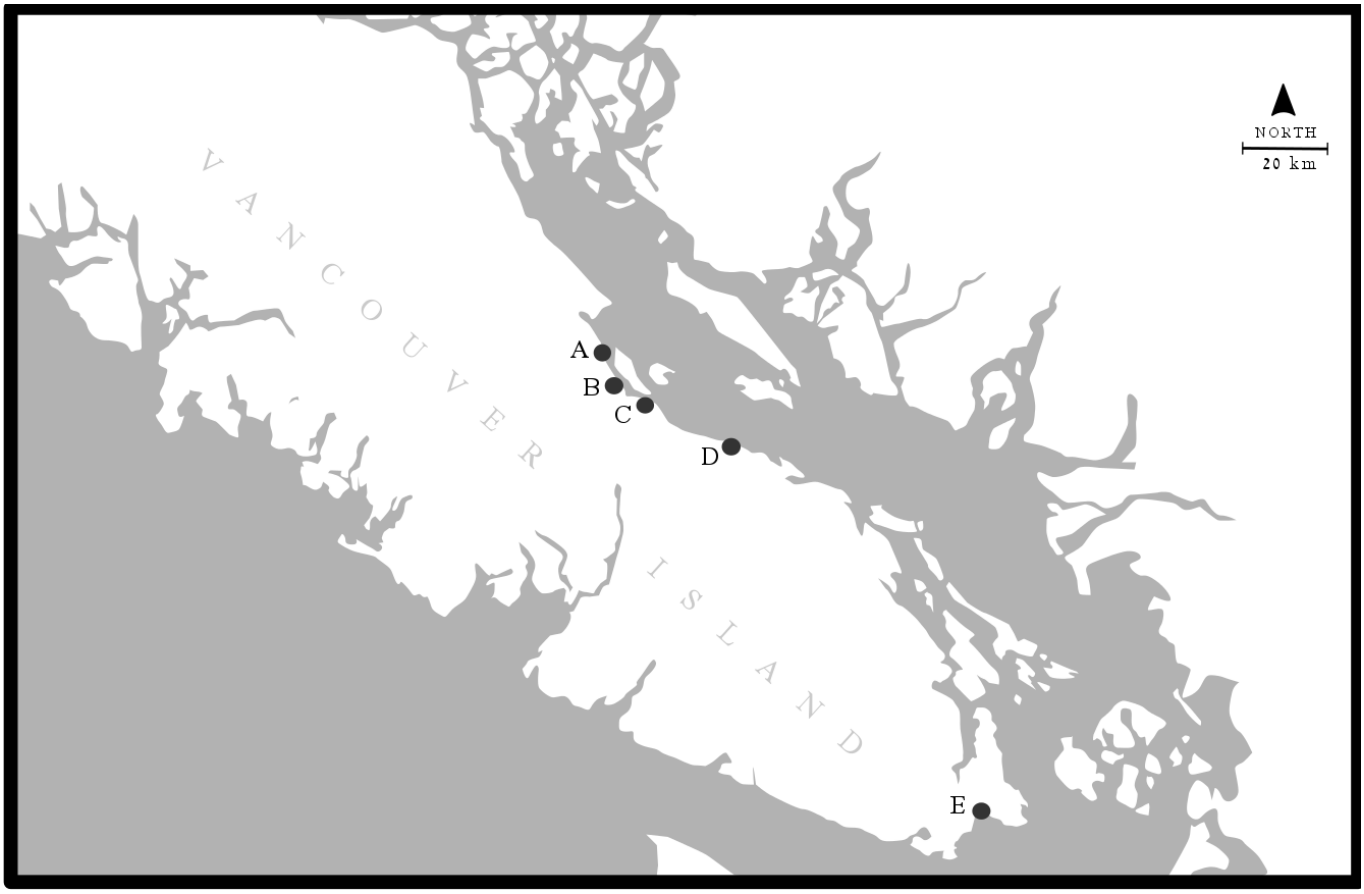

Fig. 3.6: Map of study sites. (**A**) Buckley Bay (DjSf-13) & Tsable River (DjSf-14); (**B**) Ship's Point (DjSe-6); (**C**) Deep Bay (DiSe-7); (**D**) Little Qualicum (DiSc-1); and (**E**) Maple Bank (DcRu-12).

Excavation Histories of Study Sites

Deep Bay (DiSe-7)

Deep Bay is located on the inland coast of Vancouver Island, approximately 75 km from Nanaimo. As an operational harbour for local boats, people have been active on the landscape for thousands of years. Material culture from Indigenous occupational periods was first discovered by local residents at the surface of the area. Subsequent industrial construction on and around the spit uncovered a shell midden, trench embankments, and cultural deposits that are part of a larger habitation area. The first archaeological excavation of Deep Bay shell midden contents took place in 1975 (Monks 1977), although the trench embankments have been discussed in the past in a 1975

book about the Coast Salish (Barnett 1975), and in a 1969 MA thesis focused on earthworks of southwestern BC (Buxton 1969). Deep Bay was selected in 1975 for excavation by the Archaeological Sites Advisory Board of British Columbia due to the extensive damage occurring to the midden deposits during residential and commercial development. Monks and crew were given permission to access three residential lots and excavated residential lot 73 and lot 81. Initial radiocarbon dates produced in the 1970s from charcoal suggest that site occupation ranged from 5645 ± 380 BP until 515 ± 205 BP (GAK) (Monks 1977) (Table 3.1).

Monks (1987) suggests that the rock formation present just below the intertidal zone at Deep Bay is a herring trap. This suggests the possibility that at least some of the shells present in the Deep Bay shell midden came from the use of clams as fish bait (e.g., Monks 1987). However, herring are not known to eat anything larger than krill, as they consume small prey such as phytoplankton and zooplankton. It seems unlikely that baiting the waters to attract herring would be effective. Additionally, herring would be schooling and spawning in Deep Bay regardless of whether or not the water was baited, so chumming with clams that could be used for human consumption or other means would not be an economic use of resources.

Seasonality and shellfish harvesting patterns of Deep Bay have also been topics of my own previous research (Sparrow 2016a, 2016b). I analysed bivalve macro-growth patterns of *Saxidomus gigantea* (butter clam) from Deep Bay. By examining growth lines on the ventral margin of butter clam shells, they can be classified as mature or the ratio of younger to older shells can be analysed (Cannon and Burchell 2009). These patterns imply frequency and intensity of shellfish harvesting and can be used to interpret site type, for example, a shellfish harvesting camp. DiSe-7 demonstrated a higher ratio of shells exhibiting senile-stage growth rather than mature-age growth.

When compared to other sites on the coast (Burchell et al. 2013), this suggests that Deep Bay was a residential site with low harvesting pressure rather than a seasonal occupation.

Maple Bank (DcRu-12)

Maplebank is located on Esquimalt Harbour in Victoria, on the southern tip of Vancouver Island, approximately 180km from Deep Bay. Excavations at Maplebank began in the 1970s by a team from the Royal British Columbia Museum, aided by local Indigenous band members (Stewart et al. 2019). The site is composed of a large shell midden with a house depressions and hearths. The project was funded through the BC Department of Labour "WIG '75" summer student program, and the purpose was to sample around the house depression to determine the use, extent, habitation features, burials, and their relationship to the rest of the site. One human burial was found, although several fragments of human remains were scattered throughout the site. Initial radiocarbon dating in the 1970s of charcoal suggest the site was occupied between 2245 ± 70 BP to 170 ± 70 BP (WSU) (Table 3.1) (McMurdo 1975).

There is little accessible literature on the Maplebank site. DcRu-12 is mentioned briefly in an article in a 1992 edition of *the Midden:*

> From the RBCM (Royal British Columbia Museum): Gay Frederick, Chief of Human History, is coordinating the preparation of a report on the Maplebank Site (DcRu-12) in Songhees territory in Esquimalyt. Excavated for four field seasons in the 1970s, the site has not yet been written up (Johnson 1992:8).

The site was, however, the topic of an article in *the Midden* five years previously, in which Keddie describes a female figurine carved from antler, which was recovered incidentally from an eroding shell midden in the site in 1933, as well as an antler comb (Fig. 3.7) excavated in 1976. The figure caption on the figurine suggests that the whereabouts of the artifact are currently unknown (Keddie

1987). Maplebank was revisited in 2019 by Stewart et al. (2019) to gain a better understanding of subsistence and cultural patterns at the site. Their findings contradict the traditional model of intensification of a particular abundant resource (in this case, salmon) being the driver of socioeconomic 'complexity' (Stewart et al. 2019). They suggest instead that activity at Maplebank, a small seasonally occupied site, was driven primarily by climactic events including earthquakes (Stewart et al. 2019).

Fig. 3.7: Comb carved from antler, excavated from Maplebank in 1976 (Keddie 1987).

Little Qualicum (DiSc-1)

Little Qualicum, 30 km east of Deep Bay, was primarily excavated in the 1970s. The site was divided into dry and wet portions. A fish weir was situated at the mouth of the river. The BC

Provincial archaeologist's office was alerted in 1973 by residents that the site was quickly eroding, and a one-month salvage excavation began in 1974 under the direction of Dr. Don Mitchell of the University of Victoria. In addition to mapping, salvaging artifacts, and test pitting, they also placed sandbags to slow the erosion. The sandbags fully disintegrated by 1976, and a second salvage excavation lasting two months took place by Bernick and Mitchell. Radiocarbon dating of various material, including charcoal, marine shell, and waterlogged hemlock wood suggest a date range of 1670 ± 110 BP to 760 ± 80 BP (Table 3.1) (Bernick 1983). The wooden artifacts excavated from the site have been discussed in literature (Bernick 1981), as well has the abundance of plant material from the site (Lepofsky and Lyons 2013).

Buckley Bay (DjSf-13) & Tsable River (DjSf-14)

Buckley Bay and Tsable River are located in close proximity to one another, only 400 m away on the coast of Buckley Bay. These sites were the subject of salvage excavations in the early 1970s. Wigen (1974) analysed the faunal remains from both midden sites to determine which species were collected at the sites and the relative dietary contribution of each animal to past diets. Additionally, these data were compared with three other sites, two of which are also part of this analysis: Deep Bay (DiSe-7), Little Qualicum River (DiSc-1), and a K'omoks site (DkSg-2). Wigen's results suggest that the most frequently occurring mammal species in the assemblages was the domestic dog. There are no radiocarbon dates associated with Tsable River from this study, but human bone collagen from Buckley Bay was radiocarbon dated to 2240 ± 50 BP (GAK) (Table 3.1). A preliminary report was also prepared in 1974 regarding the salvage excavations at Tsable River (Whitlam 1974).

Ship's Point (DjSe-6)

Relatively little information is available regarding the excavations at Ship's Point (DjSe-6). A thorough search through provincial archaeological archives produced one site map which situates

the site on the coast of Fanny Bay, between Deep Bay and Tsable River, about 2 km south of Buckley Bay. This was obtained through the Archaeology branch of the Ministry of Forests, Lands, and Natural Resource Operations of British Columbia. The map, in addition to a few scant site report forms stating that the excavation of the shell midden site took place in the 1970s, are the only known and available written records from DjSe-6 (Appendix 1).

Radiocarbon Dates and Site Chronologies

Although four of these sites have been radiocarbon dated in the past, these dates were produced in the later 1970s or early 1980s, therefore these dates will be viewed with caution. Deep Bay (DiSe-7) and Little Qualicum (DiSc-1) each have six associated radiocarbon dates, Maplebank (DcRu-12) has five, Buckley Bay (DjSf-13) has one, while Tsable River (DjSf-14) and Ship's Point (DjSe-6) have not yet been radiocarbon dated (Table 3.1). These dates were produced on various materials such as charcoal, marine shell, human bone collagen, and waterlogged wood.

Table 3.1: Radiocarbon dates produced in the 1970s for the six sites associated with this project

Site Name	Borden Number	Sample Type	14C Date	Error +/-	Lab Code
Deep Bay	DiSe-7	Charcoal	460	90	GaK-6034
Deep Bay	DiSe-7	Charcoal	790	80	GaK-6035
Deep Bay	DiSe-7	Charcoal	900	90	GaK-6036
Deep Bay	DiSe-7	Charcoal	1910	110	GaK-6037
Deep Bay	DiSe-7	Charcoal	2630	100	GaK-6038
Deep Bay	DiSe-7	Charcoal	4860	180	GaK-6039
Maplebank	DcRu-12	Charcoal	1310	70	WAT-1618
Maplebank	DcRu-12	Charcoal	170	70	WSU-1639
Maplebank	DcRu-12	Charcoal	1160	70	WSU-1540
Maplebank	DcRu-12	Charcoal	180	70	WSU-1541
Maplebank	DcRu-12	Charcoal	2245	70	WSU-1582
Little Qualicum	DiSc-1	Charcoal	760	80	GaK-6819
Little Qualicum	DiSc-1	Waterlogged alder wood	780	80	GaK-6820
Little Qualicum	DiSc-1	Waterlogged fir wood	1030	80	GaK-6821
Little Qualicum	DiSc-1	Waterlogged hemlock wood	1670	110	GaK-6822
Little Qualicum	DiSc-1	Marine shell	1410	100	GaK-6823
Little Qualicum	DiSc-1	Marine shell	1200	100	GaK-6824
Buckley Bay	DjSf-13	Human bone collagen	2240	50	CAMS-54729
Tsable River	DjSf-14	n/a			
Ship's Point	DjSe-6	n/a			

CHAPTER 4: Materials & Methods

To understand spatial and temporal dietary trends of dogs and people in the past, this thesis uses stable isotope-ratio mass spectrometry (IRMS), accelerator mass spectrometry (AMS) radiocarbon dating, and Fourier transform infrared spectroscopy (FTIR). IRMS provides the ratios of $^{13}C/^{12}C$ ($\delta^{13}C$) and $^{15}N/^{14}N$ ($\delta^{15}N$) to indicate protein consumption patterns. AMS dating counts the number of radioactive C14 atoms present within a sample, providing a high-precision date range. FTIR analysis assesses bone quality through detailed analysis of absorbed infrared radiation, which can be used in conjunction with established methods for evaluating the preservation of bone collagen (e.g. C/N ratio). These methods, later combined with theoretically open ways of viewing individuals, provide new insights into human dog relationships of the Coast Salish.

Sample selection: Royal British Columbia Museum

The dog bone and tooth material for this research was obtained from the Royal British Columbia Museum in 2015. The materials were excavated in the 1970's and had not been previously analyzed. Kersel (2015:44) writes, "it is a fundamental duty of archaeologists and the profession to curate and preserve excavated and surveyed resources," and offers suggestions to deal with the current issues with curation space issues facing most archaeologists. There include catch-and-release archaeology (recording and reburying) [16], removing artifacts deemed redundant, dividing artifacts among various repositories, and lending or loaning artifacts to other repositories to display (Jamieson 2015). Currently, millions of artifacts are excavated from thousands of archaeological sites annually. The permanent curation and management of these artifacts is

[16] A good example: over the past 28 years of excavation at the Colony of Avalon in Ferryland, NL (est. 1621), thousands of buckets of iron nails have been excavated. It would be an unwieldly job to curate and store every single one of them. Instead, they are recorded, closely analyzed, then if deemed redundant, returned to the ground. I spent a semester during my undergrad sorting through buckets of Ferryland nails, searching for anomalies or items of interest.

expensive, time consuming, and require large amounts of space. Far more material is excavated than could feasibly be published about, and storage space is already at capacity (Kersel 2015). This project follows this philosophy by utilizing materials that had been excavated in the past.

All information I could find about the remains (provenience, excavation dates, etc.) was recorded into an Excel spreadsheet. This information was primarily extracted from handwritten notes on brown paper bags in which the bones and teeth were held, or from notes/data inscribed on the bones themselves.

4.1(A): Artifact storage boxes at the RBCM. **4.1(B)**: Dog mandible from Deep Bay. **4.1(C)**: assorted teeth and bone fragments.

Seventy-nine dog bones and teeth were opportunistically selected from six archeological sites curated. This number is approximate because some samples listed as one item consist of one or multiple teeth attached to mandibular or maxillary bone. Bone and tooth pieces for stable isotope analysis (n=60), radiocarbon dating (n=12), and FTIR (n=12) were selected based both on

preservation and the incorporation of as many individuals as possible by using repeating elements or elements recovered from differing proveniences. Samples selected for radiocarbon dating had to weigh at least 2 g in order to extract a sufficient amount of collagen, thus special care was taken to select larger pieces of bone and larger teeth for this process (see Appendix 2 for photos of samples used for both radiocarbon dating and FTIR analysis). All of the remains were in good condition visually and this was confirmed with FTIR analysis (results explored further in this chapter).

The dog remains selected for this project consists of cranial bone elements and teeth. Using various skeletal elements can provide an opportunity to expand upon dietary variability using tissues formed both early and later in life, from a variety of individuals, and from individuals from different locations and times. Canid permanent teeth are fully formed by approximately the age of four months (Arnall 1960; Shabestari 1967). Different teeth form at different rates and will incorporate different chemical elements – those formed in-utero will demonstrate elements from the mother's diet, those formed during early puppyhood will incorporate elements from breastmilk, and teeth formed post-weaning will represent some of the first solid foods consumed (e.g., Jenkins et al. 2001; Katzenberg 2000; Richards et al 2002). Cranial bones remodel slowly, indicating dietary patterns later in life. Alveolar bone, the bone surrounding the teeth, turns over quickly (Huja et al. 2006). This turnover rate is likely due to the constant physiological strain from chewing, demonstrating dietary patterns near the end of the dog's life (Huja et al. 2006). The materials comprising bone collagen are gradually replaced with new materials derived from dietary proteins. Stable isotope analysis of dog remains provides averaged dietary data from the last six months to three years of a dog's life (Fisher et al 2007; Noe-Nygaard 1988). The samples for this analysis consist of adult dog remains, including alveolar bone from both the maxilla and mandible, some cranial bone, one vertebrae, and an assortment of mandibular and maxillary teeth.

Principles of Stable Isotope Analysis

Isotopes are atoms of the same element, such as carbon or nitrogen, that contain the same number of protons but a different number of neutrons, thus varying in atomic mass. Protons have discernable mass and carry a positive charge while electrons, with insignificant mass, carry a negative charge. Neutrons have mass similar to protons, but do not carry a charge. Most elemental atoms are balanced with an equal number of protons and neutrons (e.g. 99% of carbon is ^{12}C, carrying 6 protons and 6 neutrons). However, some carbon atoms will carry an additional neutron or two (e.g. ^{13}C and ^{14}C).

Isotopes occur in varying abundances naturally within the atmosphere. Stable isotopes, unlike radioactive isotopes (e.g. ^{14}C); do not decay over time (Katzenberg 2000). Heavier isotopes with a higher mass (e.g. ^{13}C) will react more slowly in chemical reactions, such as during the conversion of CO_2 to glucose in plants, compared to lighter isotopes (eg., ^{12}C). The result is a differing isotopic ratio in the carbon of plants compared to the carbon in atmospheric CO_2 (Katzenberg 2000). The process of differentiation in isotopic ratio is known as fractionation (Schurr 1998).

The isotopic composition of a material is measured (after extensive processing detailed further in this chapter) with an elemental analyser coupled to an isotope ratio mass spectrometer (IRMS). The quantities and ratios of stable carbon and nitrogen isotopes are produced through the forced separation of different isotopes within an IRMS. Stable isotopes are expressed as a ratio of heavier to lighter in per mil units (‰) (Schoeller 1999). These are written as a delta (δ) value. The conventional formula for a calculated stable isotope measurement is as follows: δ sample (‰) = (R sample/R standard – 1) x 1000. R represents the ratio of the heavier to the lighter isotope (e.g. $^{13}C/^{12}C$ and $^{15}N/^{14}N$). International standards (sample materials with known concentrations of

carbon and nitrogen and known isotopic values) for $\delta^{13}C$ and $\delta^{15}N$ are Vienna PeeDee Belemnite (VPDB) and the Ambient Inhalable Reservoir (AIR). Because VPDB (a synthetic version of the now-exhausted marine limestone), has a $\delta^{13}C$ value of zero, and because most biological material contains less ^{13}C compared to ^{12}C, $\delta^{13}C$ measurements most commonly produce negative values.

Carbon Isotopes

Carbon isotopes can be used to estimate the approximate contributions of terrestrial foods and marine foods to the diet of an individual (Chisolm et al. 1982). Primary producers, such as plants and plankton, synthesize carbon, and $\delta^{13}C$ values differ for plants depending on which type of photosynthetic pathway a plant utilizes. For example, wheat is a C_3 plant while maize, sorghum, and millet are C_4 plants (Katzenberg 2000; van der Merwe 1982). The photosynthetic pathways differ by the amount of fractionation that occurs within the carbon during photosynthesis. Oceans contain multiple sources of carbon which is reflected by higher $\delta^{13}C$ values in marine plants overall (van der Merwe 1982).

This information can help differentiate between the environments from which a person's food came (van der Merwe 1982). North American and European plants are almost exclusively C_3, with the exception of maize and sugarcane, while Australia and South Africa contain primarily C_4 plants (van der Merwe 1982), suggesting that terrestrial plants exposed to strong sun radiation are adapted to efficient C_4 photosynthetic pathways (van der Merwe 1982). British Columbia grows almost exclusively C3 plants. Because of this and British Columbia's large and complex series of waterways and aquatic landscapes, $\delta^{13}C$ values can be used to distinguish between terrestrial and marine proteins within an individual's diet.

Nitrogen Isotopes

While $\delta^{13}C$ generally remains constant in samples taken from the same area, $\delta^{15}N$ fluctuates based on the flow of nutrients through trophic levels (Katzenberg 2000). Because marine environments have both atmospheric carbon and marine carbonate, which looks like C_4, but also have many more trophic levels than terrestrial environments, we can use nitrogen values in combination with carbon to discern between these environments (Katzenberg 2000). The trophic level effect reflects the enrichment in $\delta^{15}N$ between the consumer and its own body tissues (Schoeninger and DeNiro 1984; Hedges and Raynard 2007). Average trophic enrichment factors in coastal British Columbia suggested by Szpak et al. (2012) are 3.6‰ (nitrogen) and 3.7‰ (carbon). Because marine environments contain more trophic levels than terrestrial environments, individuals consuming high amounts of marine proteins will demonstrate higher $\delta^{15}N$ values than individuals who consume terrestrial proteins.

Palaeodietary Reconstruction

Stable carbon (^{13}C) and nitrogen (^{15}N) analysis provides insight in to the relative abundance of marine protein and tropic level (e.g. Ambrose 1993; Katzenberg 2000). An individual's diet is recorded isotopically in their hair, nails, teeth and bone tissue, which can be measured through mass spectrometry (Katzenberg 2000) and interpreted through comparison with local floral and faunal data. Using stable isotope analysis to reconstruct palaeodiets has become well established in archaeology (e.g., Ambrose 1993; Cannon et al. 1999; Chisholm et al. 1982; Choy and Richards 2009; Grier et al. 2012; Hogue 2003; Katzenberg 2000; Richards and Hedges 1999), first utilized in the late 1970s and early 1980s (e.g., Schoeninger et al. 1983; Van der Merwe and Vogel 1978). Using stable isotope analysis in conjunction with other lines of evidence, such as zooarchaeological or ethnographic data, can provide specific nuance to understanding palaeodiets.

Principles of Radiocarbon Dating

Radiocarbon dating is an absolute dating method used to date organic material through the measurement of radioactive carbon-14 (^{14}C). Radiocarbon is continuously being created in the upper atmosphere through a number of reactions of cosmic rays, which produce thermal neutrons. These thermal neutrons then react with nitrogen atoms to form carbon-14 (Bronk Ramsay 2008). Carbon-14 bonds with CO, oxidizing to form CO_2. This enters the food chain as carbon through photosynthesis by green plants and algae, and is then absorbed by animals through consumption of plant material.

Because radiocarbon isotopes have a half-life of approximately 5,730 years, the measurement of decay can be used reliably to date organic material up to approximately 50,000 years (Bronk Ramsay 2008). Radiocarbon is only absorbed during life; after the death of an organism, absorption stops and the radiocarbon within the organism slowly begins to decay. The age of a sample is measured by comparing the concentration of ^{14}C of the sample in question to the concentration of ^{14}C in samples of which the ages are known (Bronk Ramsay 2008).

Principles and Methods of FTIR Spectrometry Analysis

Skeletal remains often undergo a number of changes post-deposition through both biological and chemical processes (Hollund et al. 2013), which can affect the accuracy of results from chemical analyses such as radiocarbon dating. Fourier Transform Infrared (FTIR) can be used to determine the degree of preservation of archaeological bone (specifically carbon apatite present in bone), teeth, and other crystalline materials based on the crystallinity index (splitting factor) of infrared spectra (Dusseault 2019; Dal Sasso et al. 2018; Weiner and Bar-Yosef 1990). FTIR provides information on both the chemical composition and crystallinity of bone (Hollund et al. 2013:508) by measuring vibrational signatures of various materials in a specimen. For this project,

FTIR analysis of phosphate and carbonate served to test the preservation of the dog bones prior to radiocarbon dating. Although the material being dated is collagen rather than carbonate, the condition of the carbonate would likely give indication to the quality of the collagen as well. This information is combined with other indicators of collagen preservation, such as acceptable C/N ratios (roughly a 3:1 ratio of carbon to nitrogen atoms, with an acceptable ratio range of ~2.9-3.6) (Schwarcz and Schoeninger 1991).

A portion of each sample was scratched to produce roughly 1 mg of bone powder, which was mixed with four parts potassium bromide (kBr) and pressed into a pellet. All spectra were obtained by transmission FTIR using the Bruker Alpha spectrometer with the Alpha-T Transmission attachment at a resolution of 4 cm^{-1}. The splitting factor was calculated by Dusseault (2019) who wrote a short python code that calculates the crystallinity index of samples following procedures by Weiner and Bar-Yosef (1990).

Collagen Extraction of Dog Samples

In order to perform dietary stable isotope analysis, collagen was extracted from 48 samples using methods based on Longin (1971), Honch et al. (2006), and Richards and Hedges (2008) in the Memorial Applied Archaeological Sciences Laboratory. Selected bone and teeth pieces were cut to a weight between 250-400 mg using a hand-held rotary drill. These pieces were then mechanically abraded using a combination of diamond steel bits attached to a rotary drill and an air-sand abrader. Enamel was removed from teeth using these diamond-steel bits, leaving only the dentin. As much trabecular bone as possible was mechanically abraded away and the dark humic material was removed. Each piece was then cleaned by sonication using an Elma E 30 H Elmasonic sonicator in small beakers of deionized water (DI H_20). Once fully dry, the pieces of bone and teeth were then individually weighed on an Ohaus Pioneer balance. The bone fragments, in individual 5ml test

tubes, were fully covered by 0.5M hydrochloric acid (HCl) solution. Lids were put on the test tubs and they were held in the refrigerator for 4˚C for one week. The solution was changed every 2-3 days until the bones became soft and demineralized.

After the bones had softened, they were removed from the HCl solution and rinsed three times with deionized water (DI H_20). As they demineralized at different rates, the fully demineralized samples were held in DI water until all remaining samples were demineralized. The bone pieces were then placed in a beaker with a 0.125M sodium hydroxide (NaOH) solution and ultrasonicated for 10-minute intervals until the colour of the solution remained clear. The bones were then removed from the NaOH solution, rinsed once more with 0.5M HCl solution, and rinsed three more times with DI H_20. The bones were then placed back into their test tubes, covered in DI water, and placed back into the refrigerator at 4˚C until all remaining samples were ready to be gelatinized.

DI H_20 was decanted from each sample and refreshed with new DI H_20. One drop of 0.5M HCl was added to each test tube and shaken. The pH level was tested using limitus paper test strips. After a pH level of three was ensured for each sample, the tubes were placed on a heater block for 48 hours at a temperature of 60˚C. After 48 hours, the heater block was turned off. Because the glass tubes are friable and may break if moved while hot, they were left to cool on the block.

Three new test tubes were labelled for each sample – two thick-walled glass tubes and one thin-walled glass test tube. Using a glass pipette, the liquid was removed from each sample, being careful not to pick up any particulate matter left on the bottom. This pipetted liquid was placed into the thin-walled test tube. The remaining particulate matter was discarded. A single-use EZ filter was pushed into each liquid-filled test tube slowly, until all liquid passed through the filter. After all of the samples had been filtered, the filtered liquid from each sample was evenly distributed between

the two thicker-walled, pre-labelled test tubes for each sample. Each tube was tightly covered with parafilm and placed at an angle in a -4˚C freezer. After 24 hours has passed, the samples were moved into the ultralow freezer and held at -60˚C until ready for lyophilisation.

For lyophilisation, the samples were placed in a freeze-drier for 48 hours, until all of the moisture was removed from the samples. The intensity of temperature changes caused several of the test tubes to crack or shatter, but they were separated from one another in such a way that cross-contamination was not a concern. Any glass fragments present on or around the samples were carefully removed using tweezers that were cleaned with acetone between samples. The remaining material was light and fluffy, similar to house insulation in texture, varying in colour from off-white to medium-brown. This material was tweezed into individually labelled plastic test tubes using tweezers sterilised with acetone between samples.

Radiocarbon Dating at the A.E. Lalonde AMS Laboratory

Collagen for radiocarbon dating was extracted from 12 samples at the A.E. Lalonde AMS laboratory in Ottawa based on methods laid out by Crann et al. (2016), which were modeled after methods established by Longin (1971), Bronk Ramsey et al. (2004), Beaumont et al. (2010), and Brock et al. (2010). The samples were assigned a media code based on pretreatment protocols. Samples were visually inspected for contaminants, cleaned and abraded with a rotary hand tool equipped with various clean stainless steel bits. After removal of any humic acid or other contaminants, bone sample were crushed to 1-2mm powder. For the tooth samples, dentin was targeted and enamel was abraded away. The dentin was then also crushed to 1-2mm powder (Crann et al. 2016).

The samples were treated with 0.5M hydrochloric acid over an 18-hour period at room temperature, until the samples became translucent. The samples were treated with 0.1M sodium

hydroxide to remove any remaining humic material, and then rinsed again with 0.5M hydrochloric acid to remove any remaining CO_2, then rinsed three times with Milli-Q water. Samples were placed in a pH 3 solution and set in a heater block at 60˚C overnight to gelatinize. After gelatinization, the samples were ultra-filtrated, centrifuged, and freeze-dried after the >30kDa fraction is removed (Crann et al. 2016).

The samples submitted for C14 were also analyzed for $\delta^{13}C$ and $\delta^{15}N$; a portion of the extracted collagen from each sample was submitted to the G.G. Hatch Stable Isotope Laboratory within the same building. This portion was analysed by isotope ratio mass spectrometry on a Thermo DeltaPlus coupled to an elemental analyzer. For radiocarbon dating, the pre-treated freeze-dried samples were packed into EA Blank tin capsules and combusted. The samples, at this point consisting of pure CO_2, were then graphitized using semi-automated graphitization lines designed and built within the A.E. Lalonde laboratory (Crann et al. 2016). The graphitized samples were then analyzed on an MV tandem accelerator mass spectrometer. The modern carbon fraction, $F^{14}C$, is calculated according to Reimer et al. (2004). Both $^{14}C/^{12}C$ ratios are background corrected and the result is corrected for spectrometer and preparation fractionation using the AMS-measured $^{13}C/^{12}C$ ratio, and is normalized to $\delta^{13}C$ (PDB). ^{14}C ages are calculated as $-8033\ln(F^{14}C)$ and reported in ^{14}C year BP (BP =AD 1950) as described by Stuiver and Polach (1977) (from Crann et al. 2016). The dates are presented here as produced through these methods.

CHAPTER 5: Results & Discussion

This chapter presents several data sets. First, data produced through radiocarbon dating of 12 samples is presented, then the results of FTIR analysis of the same 12 samples. This is followed by the results of carbon and nitrogen stable isotope analysis. The isotope values of 60 dogs from the six archaeological sites mentioned throughout the text are listed and plotted by site, collectively, and in conjunction with regional isotope values for various animal species. Mean $\delta^{15}N$ and $\delta^{13}C$ values from previous research within a broader study region are plotted in addition to mean $\delta^{15}N$ and $\delta^{13}C$ values produced by this project. A discussion of the significance of these results combined within an entangled, relational framework follows.

FTIR & C/N Results

To test the preservation of the specimens, and pre-screen materials prior to radiocarbon dating, FTIR was employed. Modern human bone has a crystallinity index of ~2.8. Based on FTIR analysis of 12 samples, the dog bones fell close to 2.8, indicating good to excellent preservation (Dusseault 2019 pers. comm.) (Table 5.2). These results are helpful for assessing the condition of bone housed in museum collections (e.g. Hollund et al. 2013; Paschalis and Mendelsohn 2011). All samples had acceptable C/N ratios, except UOC-7030 from Buckley Bay, which demonstrated a C/N ratio of 4.2. UOC-7030 was not removed from the presentation of results in this project, but is and should either be excluded from interpretation or interpreted very cautiously.

Radiocarbon (C^{14}) Dating Results

Radiocarbon dates were obtained from the collagen of 12 dogs (two samples per site) providing new dates for all the sites and dating two sites which have not been chemically dated before (Tsable River and Ship's Point) (Table 5.1) (Fig. 5.1). The dates were calibrated to 2-sigma using OxCal v.4.2.4 (Bronk Ramsay 2009).

As previously shown in Table 3.1, the majority of the dates previously produced for these sites were produced by the Gakushuin laboratory (GAK). New dates for these sites were necessary because dates produced by GAK are no longer considered truly accurate (Blakeslee 1994). The materials used to produce the previous dates also came primarily from charcoal. Dates produced from charcoal are potentially less accurate than dates produced from bone due to what is known as the "old wood effect" (Brock et al. 2010; Kim et al. 2019; Nowak et al. 2017; Schiffer 1986; Whittle 1990), where the age of the wood being dated may not match the timeframe in which the wood was actually used. The dates for this project were produced only from dog bone and tooth material and all dates were produced at the Lalonde Radiocarbon Laboratory. The old and new dates are often similar to one another – For example, Monks (1977:61) produced six dates for Deep Bay ranging from cal. 515±205 BP to 5645±380 BP (Table 3.1), while the two dates for Deep Bay produced by this research fall around ~1650 BP. There appears to be overlap with the results of previous studies to the date ranges produced here. However, the dates produced here are generally more consistent with one another compared to the results produced in the 1970s.

Table 5.1: Calibrated results of radiocarbon dating, adjusted to 2-σ

SAMPLE ID	Lab Code	14C age	±	d13C IRMS (per mille)	%Marine C=/- 10	Cal years BP
Deep Bay	UOC-7024	1649	24	-12.34	0.913385827	2924-2496
Deep Bay	UOC-7025	1624	25	-12.09	0.946194226	1699-1351
Tsable River	UOC-7026	3621	30	-11.76	0.989501312	4146-3717
Tsable River	UOC-7027	3222	28	-12.58	0.881889764	3610-3251
Little Qualicum	UOC-7028	1190	24	-12.75	0.859580052	1275-960
Little Qualicum	UOC-7029	1158	39	-14.37	0.646981627	1265-931
Buckley Bay	UOC-7030	1080	55	-15.07	0.55511811	1234-790
Buckley Bay	UOC-7031	3057	27	-12.57	0.8832021	3444-3036
Maple Bank	UOC-7192	2759	29	-12.02	0.955380577	3057-2745
Maple Bank	UOC-7033	1937	42	-12.29	0.919947507	2110-1637
Ship's Point	UOC-7034	2131	24	-13.11	0.812335958	2318-1944
Ship's Point	UOC-7035	2191	46	-12.9	0.839895013	2348-1994

Because the dogs were primarily eating high trophic marine foods, as evidenced by the stable isotope values produced by these samples, the marine reservoir effect must also be taken into account. The radiocarbon content of marine organisms is different from those of terrestrial organism. This can vary based on global location. In this case, known reservoir ages of locations near these six sites (<50km) produce an average of offsets from the eastern Vancouver Island area ($\Delta R=232 \pm 75$), which can be applied to the dates here.

Table 5.2: Bone splitting factor results from FTIR analysis. The closer the number is to 3, the better the preservation of the carbonate and phosphate of the bone

Sample Code	Sample #	Site	Borden	Splitting factor
AS_DB1_F1	1	Deep Bay	DiSe-7	2.997
AS_DB2_F2	2	Deep Bay	DiSe-7	3.072
AS_TR1_F3	3	Tsable River	DjSf-14	3.189
AS_TR2_F4	4	Tsable River	DjSf-14	2.778
AS_LQ1_F5	5	Little Qualicum	DiSe-1	2.944
AS_BB1_F6	6	Buckley Bay	DjSf-13	2.923
AS_BB2_F7	7	Buckley Bay	DjSf-13	2.725
AS_SP1_F9	8	Maple Bank	DcRu-13	2.786
AS_SP1_F9	9	Ship's Point	DjSe-6	2.743
AS_SP2_F10	10	Ship's Point	DjSe-6	2.731
AS_LQ2_F11	11	Little Qualicum	DiSe-1	2.798
AS_MB2_F12	12	Maple Bank	DcRu-13	2.873

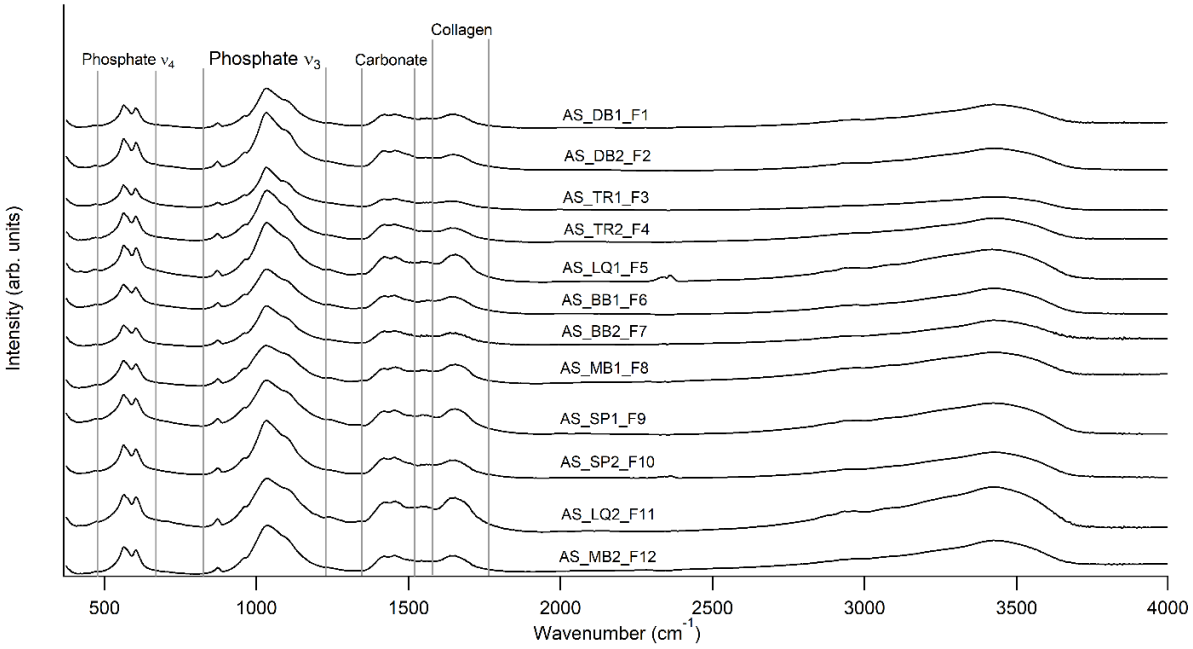

Fig. 5.1: Results of FTIR spectra. The intensity of the reaction of the mineral to the infrared is measured in waves. The phosphate (v4) vibrational mode is used to calculate splitting factor of the material (Dusseault 2019).

Table 5.3: C:N ratios of all samples

Site	Borden	Sample ID	C:N
Deep Bay	DiSe-7	DB-4461-B	3.2
Deep Bay	DiSe-7	DB-4462-B	3.2
Deep Bay	DiSe-7	DB-4463-B	3.2
Deep Bay	DiSe-7	DB-4464-B	3.2
Deep Bay	DiSe-7	DB-4465-B	3.2
Deep Bay	DiSe-7	DB-4466-B	3.2
Little Qualicum	DiSc-1	LQ-4467-B	3.2
Tsable River	DjSf-14	TR-4468-B	3.2
Tsable River	DjSf-14	TR-4469-B	3.2
Tsable River	DjSf-14	TR-4470-B	3.2
Tsable River	DjSf-14	TR-4471-B	3.2
Tsable River	DjSf-14	TR-4472-B	3.2
Tsable River	DjSf-14	TR-4473-B	3.2
Buckley Bay	DjSf-13	BB-4474-B	3.2
Buckley Bay	DjSf-13	BB-4475-B	3.1
Buckley Bay	DjSf-13	BB-4477-B	3.2
Buckley Bay	DjSf-13	BB-4478-B	3.2
Maple Bank	DjSe-6	MB-4479-B	3.2
Ship's Point	DjSe-6	SP-4480-B	3.2
Ship's Point	DjSe-6	SP-4481-B	3.2
Ship's Point	DjSe-6	SP-4482-B	3.2
Ship's Point	DjSe-6	SP-4483-B	3.2
Ship's Point	DjSe-6	SP-4484-B	3.2
Ship's Point	DjSe-6	SP-4485-B	3.2
Ship's Point	DjSe-6	SP-4486-B	3.2
Ship's Point	DjSe-6	SP-4487-B	3.2
Ship's Point	DjSe-6	SP-4488-B	3.2
Ship's Point	DjSe-6	SP-4489-B	3.2
Ship's Point	DjSe-6	SP-4490-B	3.2
Deep Bay	DiSe-7	DB_4602_T	3.2
Deep Bay	DiSe-7	DB_4603_T	3.2
Deep Bay	DiSe-7	DB_4604_T	3.2
Deep Bay	DiSe-7	DB_4605_T	3.2
Tsable River	DjSf-14	TR_4606_T	3.2
Tsable River	DjSf-14	TR_4607_T	3.2
Tsable River	DjSf-14	TR_4608_T	3.2
Tsable River	DjSf-14	TR_4609_T	3.2
Tsable River	DjSf-14	TR_4610_T	3.2
Tsable River	DjSf-14	TR_4611_T	3.2
Tsable River	DjSf-14	TR_4612_T	3.2
Tsable River	DjSf-14	TR_4613_T	3.2
Maple Bank	DcRu-12	MB_4614_T	3.2
Maple Bank	DcRu-12	MB_4615_T	3.2
Maple Bank	DcRu-12	MB_4616_T	3.3
Maple Bank	DcRu-12	MB_4618_T	3.2
Maple Bank	DcRu-12	MB_4619_T	3.2
Buckley Bay	DjSf-13	BB_4620_T	3.2
Deep Bay	DiSe-7	UOC-7024	3.2
Deep Bay	DiSe-7	UOC-7025	3.3
Tsable River	DjSf-14	UOC-7026	3.3
Tsable River	DjSf-14	UOC-7027	3.3
Little Qualicum	DiSc-1	UOC-7028	3.2
Little Qualicum	DiSc-1	UOC-7029	3.3
Buckley Bay	DjSf-13	UOC-7031	2.8
Buckley Bay	DjSf-13	UOC-7030	4.2
Maple Bank	DcRu-12	UOC-7033	3.3
Maple Bank	DcRu-12	UOC-7034	2.8
Ship's Point	DjSe-6	UOC-7032	3.4
Ship's Point	DjSe-6	UOC-7035	3.4

Nitrogen Isotope ($\delta^{15}N$) & Carbon Isotope ($\delta^{13}C$) Results

The results of stable nitrogen and carbon isotope analysis is presented for each individual site before the results are compared between the sites. In total, 60 individual dogs were analysed. Six samples were repeated as quality control duplicates (QCDs) – one from each site except for Little Qualicum. The QCDs are included in the data sets, but not calculated into the total number of individual dogs. A complete table of $\delta^{13}C$ and $\delta^{15}N$ values from all samples and elemental data can be found in Appendix 3.

Deep Bay (DiSe-7)

Stable isotope values of 12 dogs from Deep Bay are presented in Fig. 5.2. The mean $\delta^{15}N$ value calculated for these dogs is 17.1‰. The mean $\delta^{13}C$ value is -11.9‰. There are no significant outliers within this data set. The $\delta^{13}C$ range measures from -13.0‰ to -11.0‰ and the $\delta^{15}N$ range measures from 15.8‰ to 18.9‰.

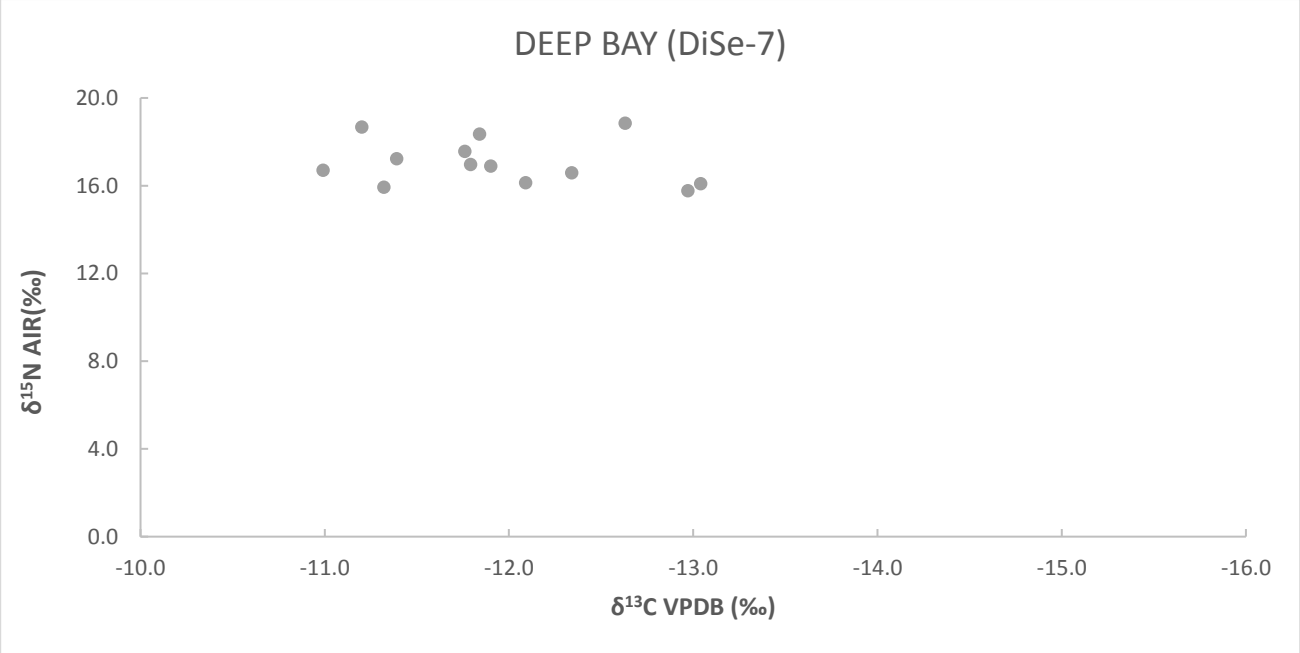

Fig. 5.2: Results of carbon and nitrogen stable isotope analysis of 12 dogs from Deep Bay

Little Qualicum (DiSc-1)

Stable isotope values of three dogs from Little Qualicum are presented in Fig. 5.3. The mean $\delta^{15}N$ value calculated for these dogs is 16.6‰. The mean $\delta^{13}C$ value is -13.3‰. The $\delta^{13}C$ range measures from -14.4‰ to -12.7‰ and the $\delta^{15}N$ range measures from 16.3‰ to 17.14‰. Two of the samples demonstrated almost exactly the same $\delta^{15}N$ and $\delta^{13}C$ values, while the third demonstrated a higher $\delta^{13}C$ value (by -1.62‰) and a higher $\delta^{15}N$ value (by 0.8‰).

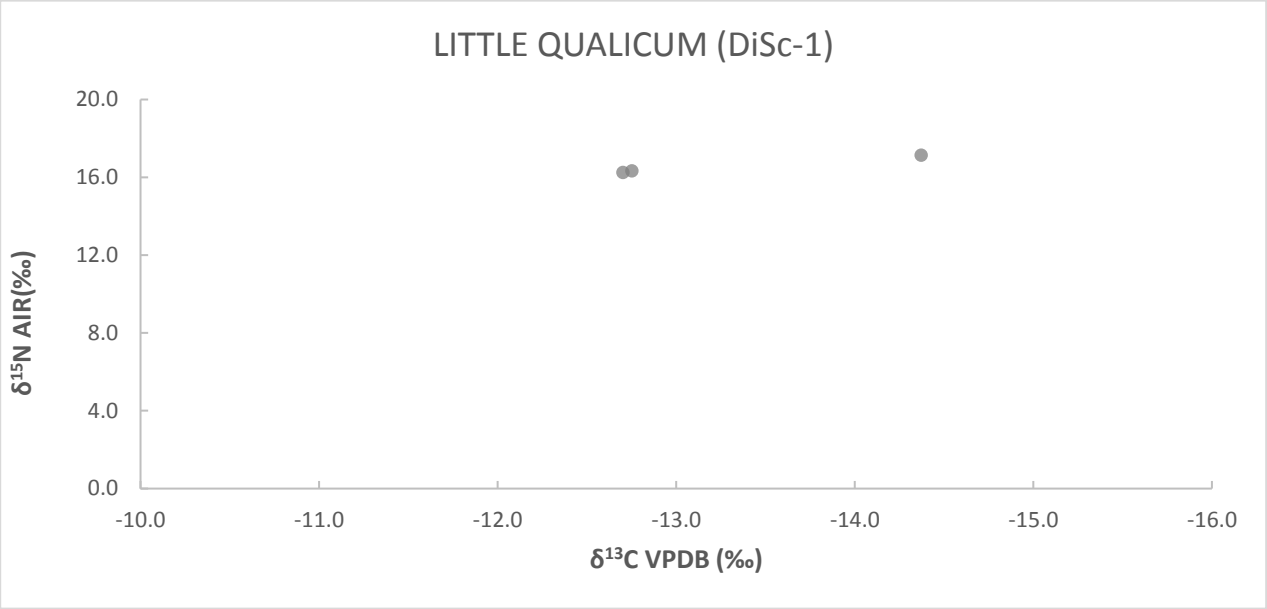

Fig. 5.3: Results of carbon and nitrogen stable isotope analysis of three dogs from Little Qualicum.

Ship's Point (DjSe-6)

Stable isotope values of 13 dogs from Ship's Point are presented in Fig. 5.4. The mean $\delta^{15}N$ value calculated for these dogs is 17.2‰. The mean $\delta^{13}C$ value is -12.2‰. The $\delta^{13}C$ range measures from -12.9‰ to -11.7‰ and the $\delta^{15}N$ range measures from 15.9‰ to 18.4‰. The data points are more tightly clustered compared to the other sites, with little variation between carbon values (a difference of -1.2‰ among 13 samples).

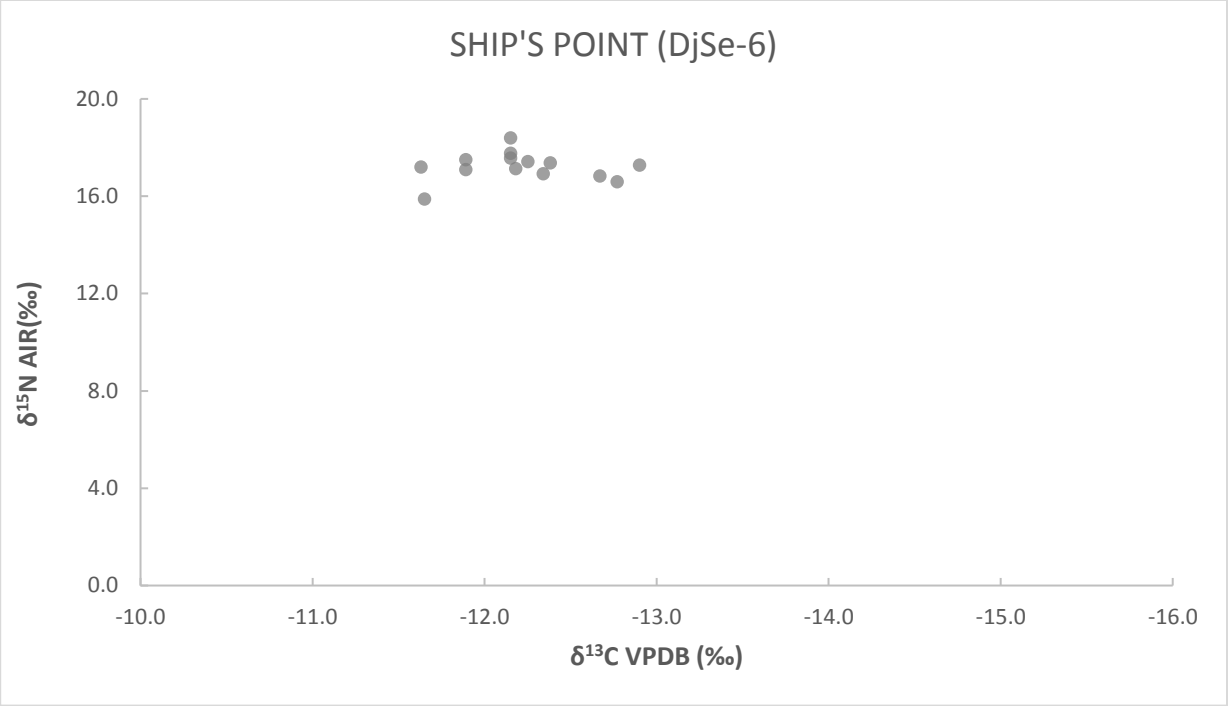

Fig. 5.4: Results of carbon and nitrogen stable isotope analysis of 13 dogs from Ship's Point.

Tsable River (DjSf-14)

Stable isotope values of 16 dogs from Ship's Point are presented in Fig. 5.5. The mean $\delta^{15}N$ value calculated for these dogs is 17.9‰. The mean $\delta^{13}C$ value is -11.9‰. The $\delta^{13}C$ range measures from -12.9‰ to -11.4‰ and the $\delta^{15}N$ range measures from 16.0‰ to 19.5‰. At least four of these dogs demonstrate $\delta^{15}N$ values higher than any values produced by the other sites, and three other dogs are at the upper range of $\delta^{15}N$ produced by the other sites (see Fig. 5.9).

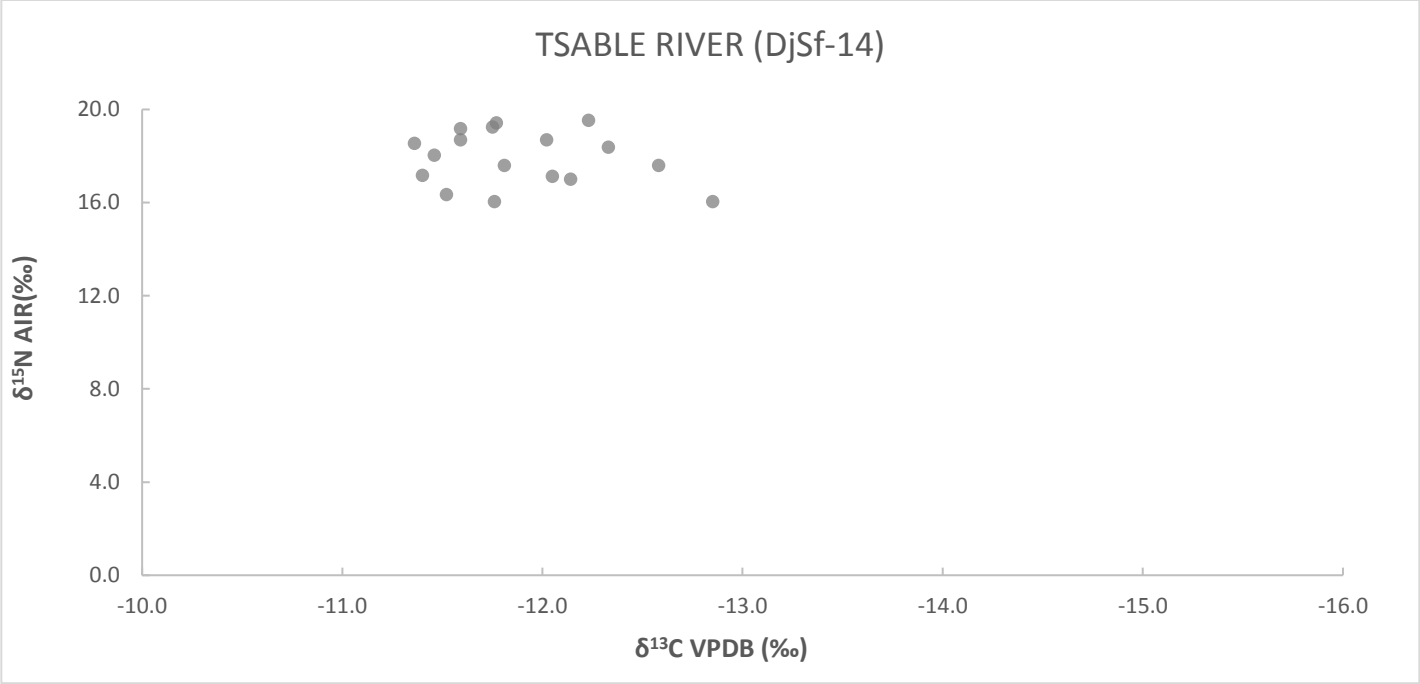

Fig. 5.5: Results of carbon and nitrogen stable isotope analysis of 16 dogs from Tsable River.

Buckley Bay (DjSf-13)

Stable isotope values of seven dogs from Buckley Bay are presented in Fig. 5.6. The mean $\delta^{15}N$ value calculated for these dogs is 16.9‰. The mean $\delta^{13}C$ value is -12.6‰. The $\delta^{13}C$ range measures from -15.1‰ to -11.9‰ and the $\delta^{15}N$ range measures from 14.8‰ to 18.5‰. Conversely, even though Buckley Bay is adjacent to Tsable River, which just demonstrated overall higher $\delta^{15}N$ than any other site, Buckley Bay exhibits the two lowest $\delta^{15}N$ values (14.8‰ and 15.4‰) as well as the lowest $\delta^{13}C$ value (-15.1‰). One of these samples appears to be a significant outlier ($\delta^{13}C$ -15.1‰, $\delta^{15}N$ 14.8‰).

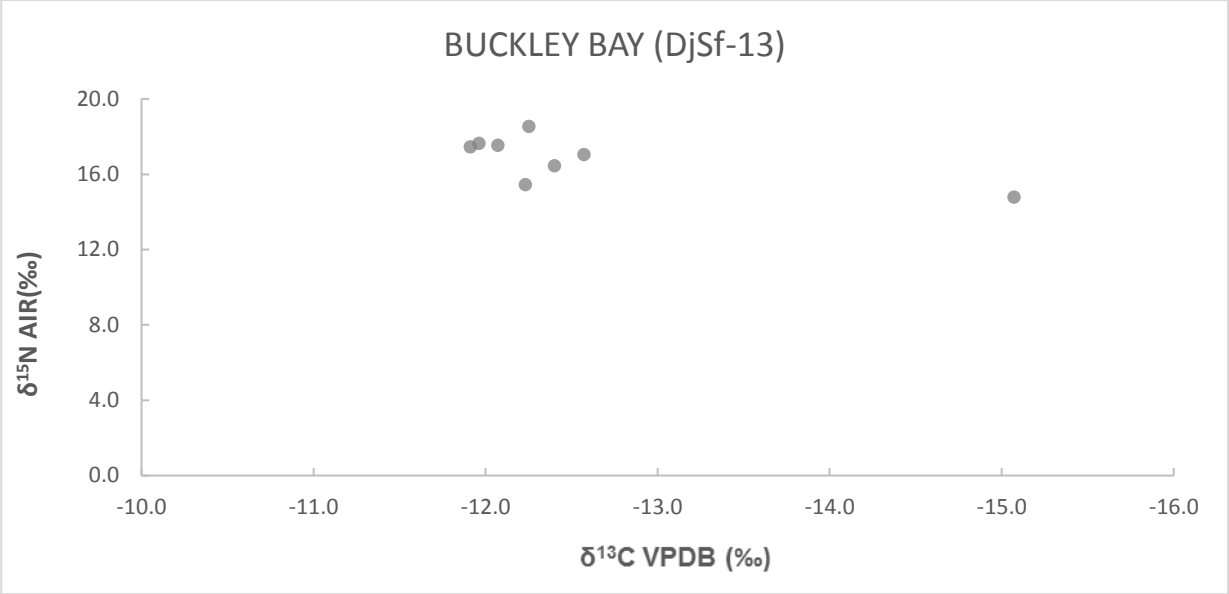

Fig. 5.6: Results of carbon and nitrogen stable isotope analysis of seven dogs from Buckley Bay.

Maple Bank (DcRu-12)

Stable isotope values of eight dogs from Maple Bank are presented in Fig. 5.7. The mean $\delta^{15}N$ value calculated for these dogs is 17.5‰. The mean $\delta^{13}C$ value is -12.4‰. The $\delta^{13}C$ range measures from -13.2‰ to -11.9‰ and the $\delta^{15}N$ range measures from 16.2‰ to 18.5‰.

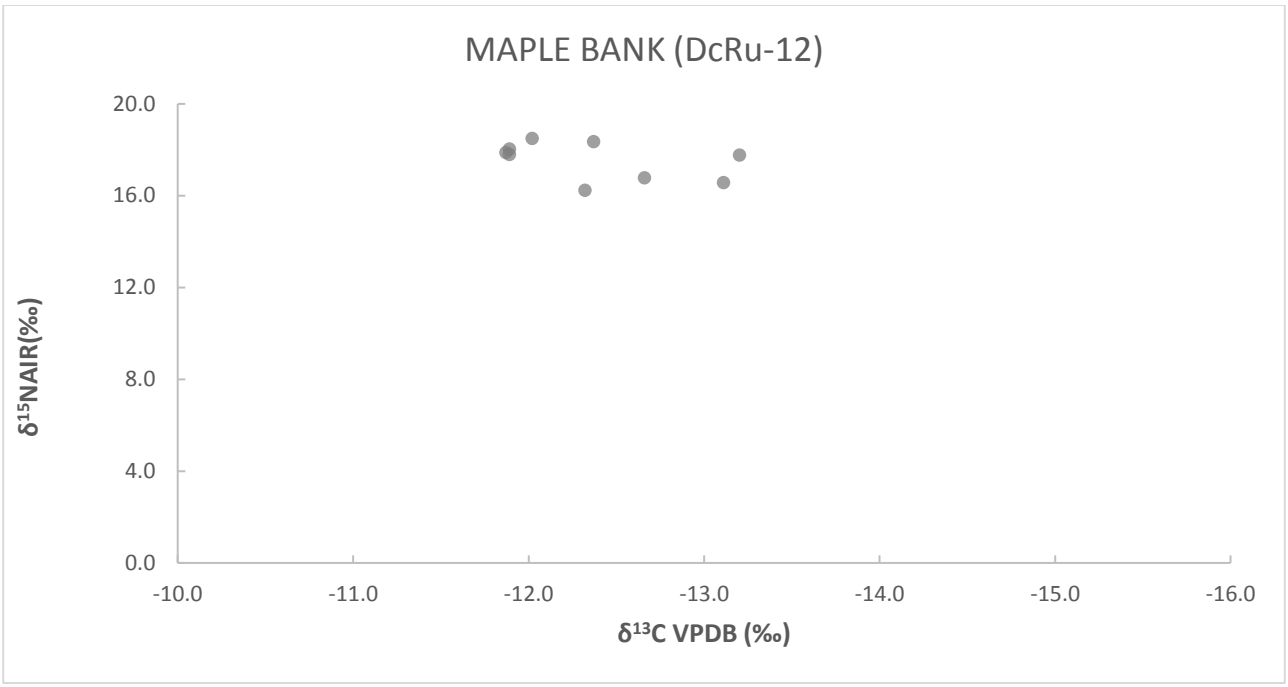

Fig. 5.7: Results of carbon and nitrogen stable isotope analysis of eight dogs from Maple Bank.

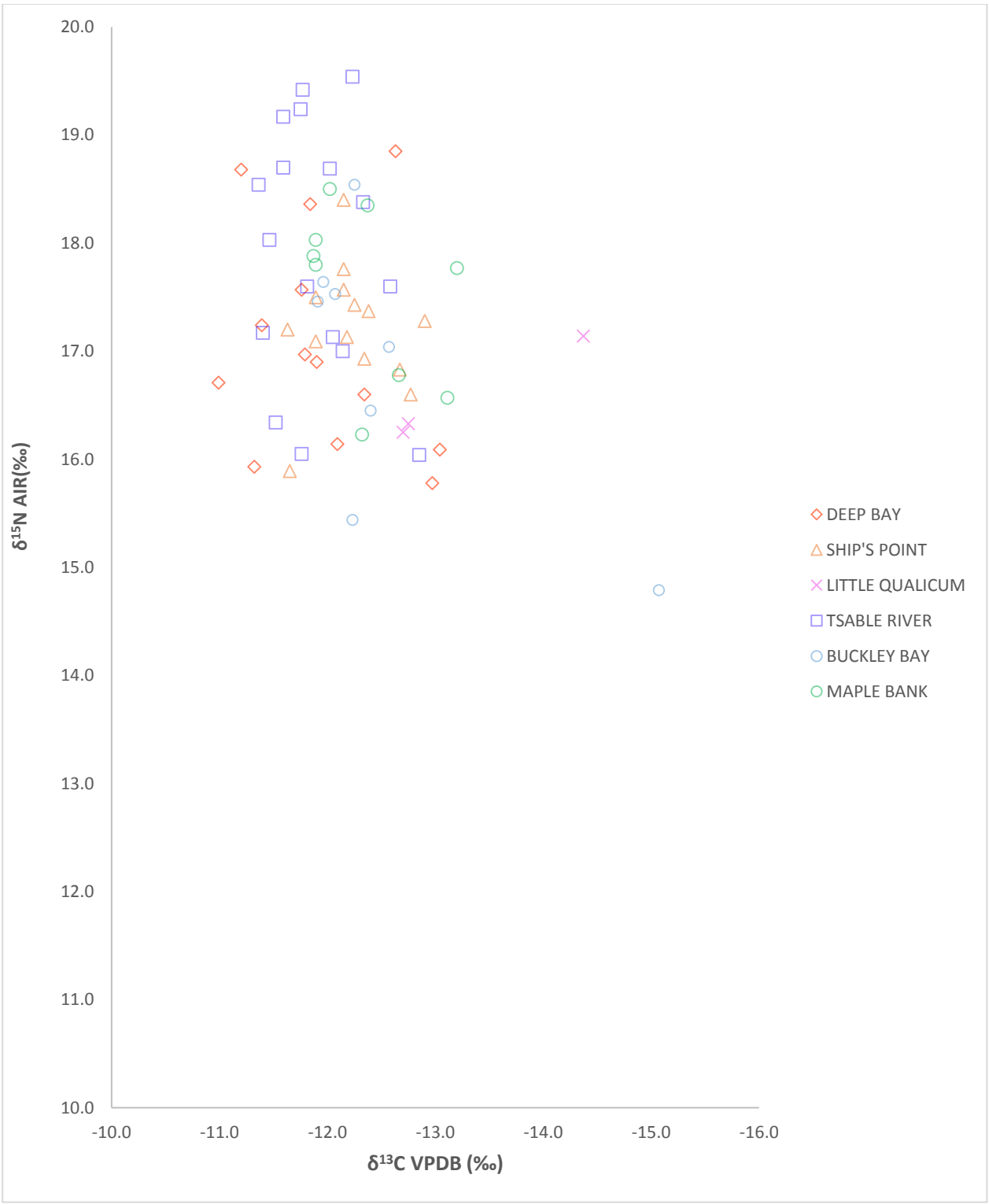

Fig. 5.8 Results of carbon and nitrogen stable isotope analysis of 60 dogs from all six sites.

Discussion

This project is to use multiple lines of evidence (stable isotope analysis, radiocarbon dating, traditional narratives) within a relational framework to create a more comprehensive understanding of human-dog relationships of the Coast Salish through diet. By determining what proteins dogs were eating, and recognizing the social, emotional, and physical roles held by these dogs, we can provide new insights into how two species coexisted within a specific spatial and temporal frame. The data produced by this project can also be put within a larger context in conjunction with data produced by other researchers (e.g., Cannon et al. 1999; Diaz 2019; Szpak 2009) in order to better understand settlement and subsistence patterns and relationships over time and space. The potential for a pan-coastal data set is explored further at the end of this chapter.

The following research questions will be addressed throughout this discussion:

1) What were Coast Salish dogs eating?
2) Do dog diets vary or remain consistent over time and space?
3) Within a relational framework, the relationship between humans and dogs is explored using dietary information and traditional narrative.

What were Coast Salish Dogs Eating?

It has been established that dog remains can be used as isotopic proxies for human diet (e.g., Burleigh and Brothwell 1987; Cannon et al. 1999; Guiry 2012; Noe-Nygaard 1988; West and France 2015) and this phenomena (deemed the canine surrogacy approach [CSA] by Guiry 2013) occurs because dogs and humans are intrinsically close to one other, both spatially and emotionally. This long-term bond suggests that dogs and humans would frequently be sharing meals, leading to dogs and humans exhibiting close $\delta^{15}N$ and $\delta^{13}C$ values to one another. Other things that can lead to the synchronization of dietary isotope values include coprophagia and scavenging, other behaviours

often seen in modern dogs. All of the dogs in this data set exhibit isotope values indicating the regular consumption of proteins that they would not naturally hunt, such as high-trophic marine mammals and fish (Fig. 5.8).

In order to put this data into dietary context, known isotope values from regional animal species can be plotted against values produced by the dogs. In this case, $\delta^{13}C$ and $\delta^{15}N$ values from Haida Gwaii species were analyzed and used to compare to the dog values produced here (Table 5.4). By plotting the dog data against the values of regional species, we can extrapolate what types of proteins the dogs were regularly consuming.

Table 5.4: $\delta^{13}C$ and $\delta^{15}N$ values for various animal species from Haida Gwaii. (Spzak et al 2009). For full list of animal species and values, see Appendix 4

Species	$\delta^{13}C$	$\delta^{15}N$
Salmon	-15.1	12.2
Nearshore fish	-10.8	15.6
Pelagic fish	-13.6	13.5
Seals	-12.0	19.0
Dolphin	-11.3	16.1
River otter	-10.7	19.6
Sea otter	-10.9	13.6
Black bear	-19.3	4.0

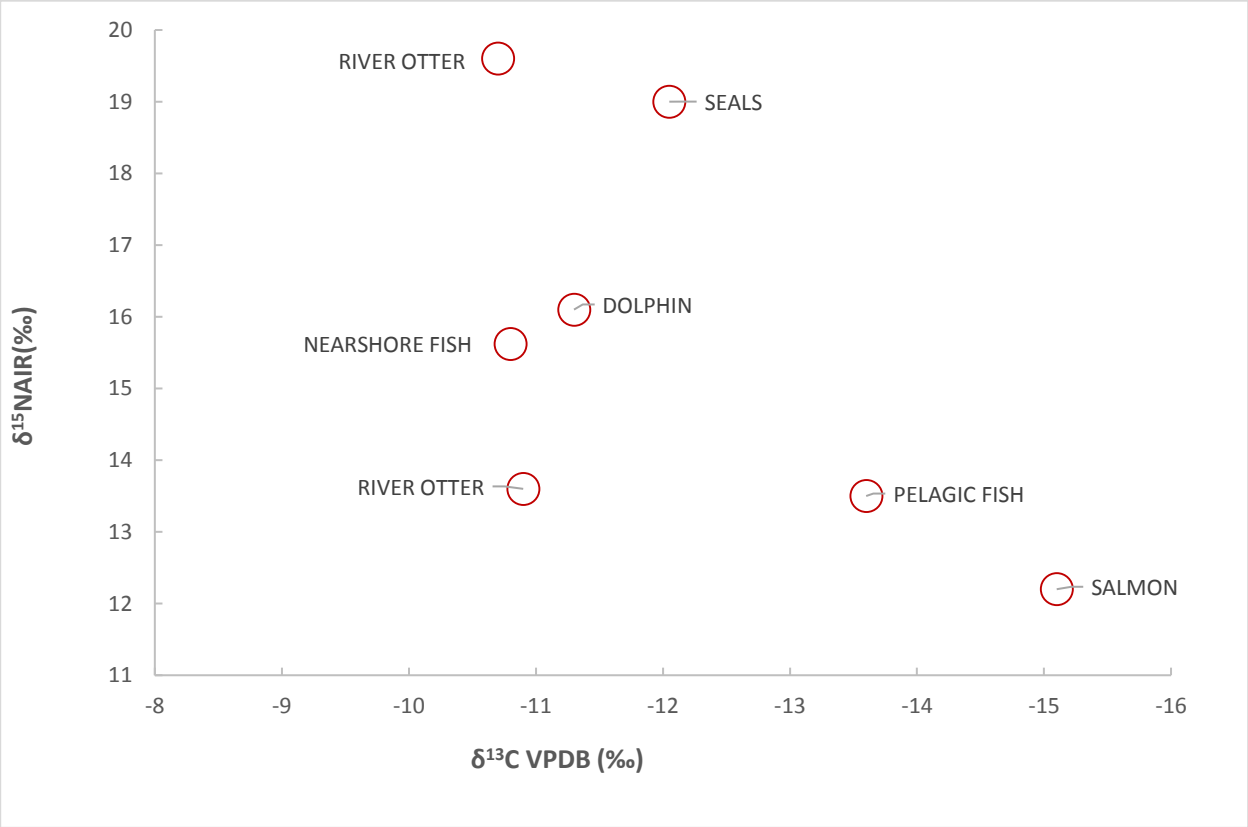

Fig. 5.9: $\delta^{13}C$ and $\delta^{15}N$ values for various animal species from Haida Gwaii (Spzak 2009).

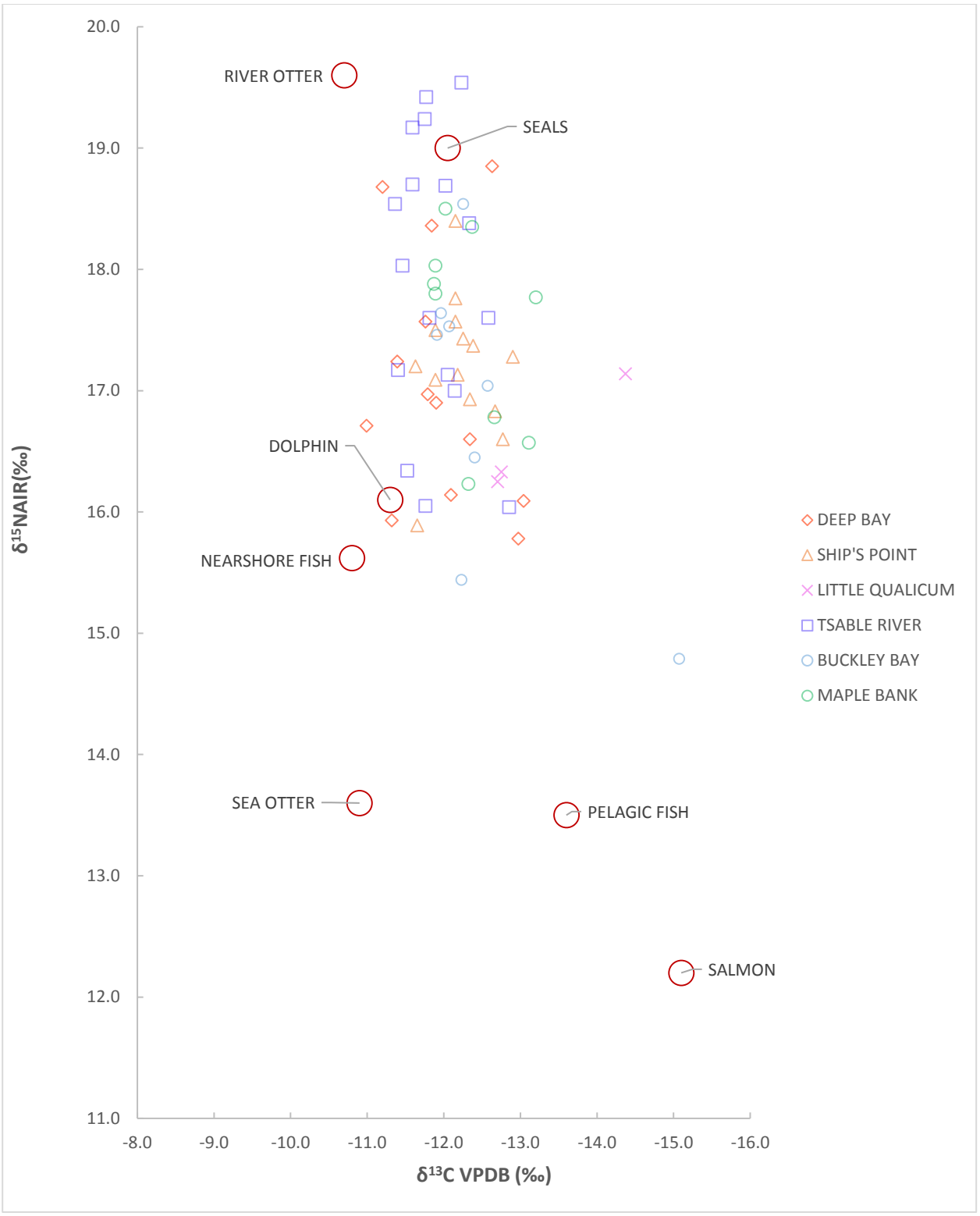

Fig. 5.10: Carbon and nitrogen data from all six sites plotted against known $\delta^{15}N$ and $\delta^{13}C$ values of regional species (Szpak et al. 2009).

As expected, dogs were consuming high-trophic marine proteins regularly, including several types of fish. Unexpectedly, salmon does not appear to constitute a major component of the diet of the dogs in this study. Data suggests dogs more regularly consumed higher-trophic marine proteins (Fig. 5.11). Additionally, while dog diets appear to have minor variation within each site, they also have visible geo-specific trends. For example, Little Qualicum (DiSc-1) has a mean $\delta^{15}N$ value almost 2.0‰ lower and a $\delta^{13}C$ value almost 1.5‰ lower than Tsable River's mean $\delta^{13}C$ and $\delta^{15}N$ values (DjSf-14) (Fig. 5.11). This suggests that dogs at Tsable River may have eaten a more varied diet than dogs from Little Qualicum.

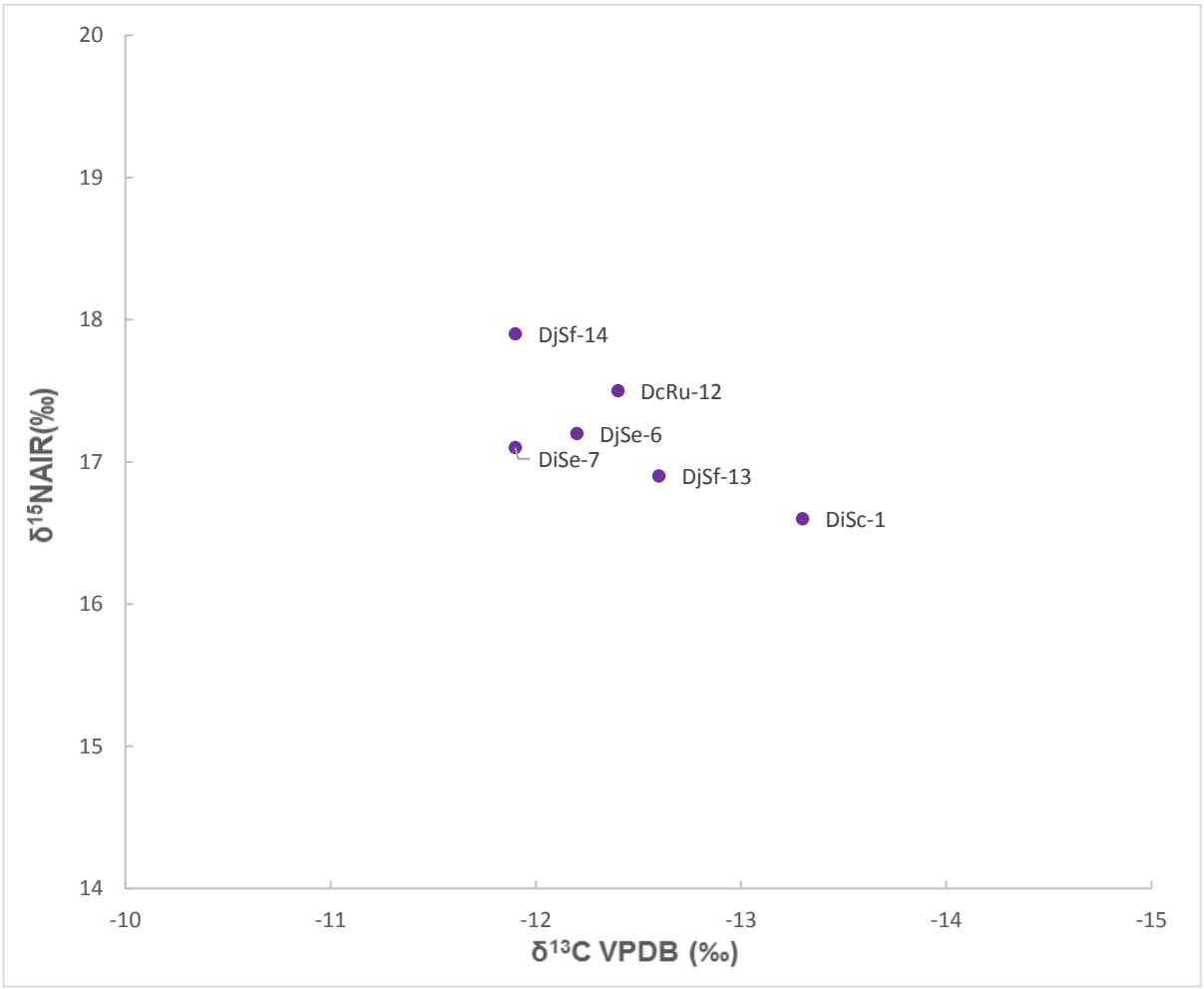

Fig. 5.11: Mean $\delta^{13}C$ and $\delta^{15}N$ values from each site in this study.

Table 5.5: Mean $\delta^{13}C$ and $\delta^{15}N$ values from each site in this study

Site	Borden	δ13C	δ15N	#
Deep Bay	DiSe-7	-11.9	17.1	13
Little Qualicum	DiSc-1	-13.3	16.6	3
Tsable River	DjSf-14	-11.9	17.9	17
Buckley Bay	DjSf-13	-12.6	16.9	8
Maple Bank	DcRu-12	-12.4	17.5	9
Ship's Point	DjSe-6	-12.2	17.2	14

Dogs in this study exhibit very different $\delta^{13}C$ and $\delta^{15}N$ values than those displayed by their wild canid relatives in the Pacific Northwest. Although a coyote haplotype has been identified in some archaeological dogs (Barta 2006), as noted in the previous chapter, there is no actual archaeological evidence of coyote at all in this region. Diaz (2019) sampled six canids, two positively identified as wolves and four believed to be wolf from EeRl-4. These samples demonstrated a mean $\delta^{13}C$ value of -20.3±0.4 and a mean $\delta^{15}N$ value of 3.7±0.5‰, indicating a diet of low trophic herbivorous prey, highly contrasting the results of dog isotope values from this and other studies (Fig. 5.12). Wolves consume primarily ungulate prey[17] - specifically elk, deer, and moose (Hatler et al. 2008), as well as beavers and birds (Culling et al. 2006) – leading to wolves demonstrating very low nitrogen values. The $\delta^{13}C$ and $\delta^{15}N$ values produced from the dog samples in this study, when compared against contemporaneous wild canid $\delta^{13}C$ and $\delta^{15}N$ values strongly indicate that humans supplied dogs with food throughout the dog's life.

[17] Exceptions exist, of course. https://www.nationalgeographic.com/news/2016/08/sea-oceans-wolves-animals-science/

Pan-Coastal Interpretations

This isotopic relationship has been demonstrated already in other regions of the Pacific Northwest Coast. On the central coast of British Columbia, dog bones and human bones from Heiltsuk site Namu (ElSx-1) demonstrate virtually identical mean $\delta^{13}C$ values: -13.3±0.6‰ $\delta^{13}C$ from 15 dogs (Cannon et al. 1999) and -13.2±0.5‰ $\delta^{13}C$ from 14 human burials (Cannon et al. 1999; Chisholm, Nelson & Schwarcz 1983). One dog's diet appeared to be potentially 100% marine based (Cannon et al. 1999:402). Cannon et al. (1999:402) write, "Dogs at [Namu] evidently obtained as much of their diet from marine sources as did humans. Dogs must have obtained their food directly or indirectly from human consumers." Stable carbon and nitrogen analysis of 14 Namu dogs six years later produced almost identical mean $\delta^{15}N$ and $\delta^{13}C$ values ($\delta^{13}C$ -12.9±0.4‰, $\delta^{15}N$ 16.9±0.7‰) (Barta 2006), clearly indicating humans and dogs shared resources.

Isotopic analysis of dog remains provides valuable data about northwest coast subsistence and settlement patterns. Dog remains are "sensitive indicators of temporal variability in the consumption of marine foods" (Cannon et al.1999:404) and can provide insight into subtle variations in food strategies over time and space, even within a heavily marine food economy (Cannon et al. 1999). Although "the role of dogs in north-west coast prehistory […] is not well known" (Cannon et al. 1999:405), dogs are considered reliable isotopic proxies for human diet because of their long-term spatial and temporal entanglement.

On the southern coast, on the opposite side of the Salish Sea from this project's study region, Diaz (2019) demonstrates this relationship between species again though the analysis of 146 dog remains from six archaeological sites (Table 5.5). These results suggest that dogs were eating marine proteins to the exclusion of terrestrial resources (Diaz 2019:84), indicating that dogs were either exclusively fed by or scavenged from humans – or perhaps a bit of both. Diaz writes that

these results are "especially noteworthy as it provides direct subsistence-oriented evidence of the prolonged relationship between dogs and humans at the scale of individual dogs and at the scale of nearly all dogs in the Fraser watershed through time" (Diaz 2019:84). Barta (2006) produced stable carbon and nitrogen isotope values for six dogs from Keatley Creek, a site also analysed by Diaz (2019). Barta's (2006) mean values ($\delta^{13}C$ -16.1±0.9‰, $\delta^{15}N$ 13.7±1.7‰) are very close to Diaz's (2019) mean values (n=21, $\delta^{13}C$ -16.5±1.3‰, $\delta^{15}N$ 13.8±2.3‰), suggesting that dogs at this site have been eating a stable diet over time, which likely would have been controlled by humans.

Table 5.6: Mean $\delta^{13}C$ and $\delta^{15}N$ values from archaeological dogs within the Pacific Northwest

Site	Borden	Location	d13C	±	d15N	±	#	Reference
Deep Bay	DiSe-7	Vancouver Is.	-11.9	/	17.1	/	13	Sparrow 2020
Little Qualicum	DiSc-1	Vancouver Is.	-13.3	/	16.6	/	3	Sparrow 2020
Tsable River	DjSf-14	Vancouver Is.	-11.9	/	17.9	/	17	Sparrow 2020
Buckley Bay	DjSf-13	Vancouver Is.	-12.6	/	16.9	/	8	Sparrow 2020
Maple Bank	DcRu-12	Vancouver Is.	-12.4	/	17.5	/	9	Sparrow 2020
Ship's Point	DjSe-6	Vancouver Is.	-12.2	/	17.2	/	14	Sparrow 2020
Cathlapotle	/	Columbia River	-14.5	0.6	16.4	0.8	5	Ames et al. 2015
Dioniso Point	DgRv-003	Galianio Is.	-13	/	16	/	5	Grier 2006
Keatley Creek	EeRl-4	Fraser River W.	-16.1	0.9	13.7	1.7	6	Barta 2006
Namu	ElSx-1	Central Coast	-13.3	0.6	16.4	0.8	15	Cannon et al. 1999
Namu	ElSx-1	Central Coast	-12.9	0.4	16.9	0.7	14	Barta 2006
Tsawwassen	DgRs-2	Fraser River W.	-13.5	0.6	15.3	0.4	9	Diaz 2019
Water Hazard	DgRs-30	Fraser River W.	-13.5	0.6	15.6	0.5	49	Diaz 2019
Crescent Beach	DgRr-1	Fraser River W.	-13.7	1.3	15.7	1.1	47	Diaz 2019
Port Hammond	DhRp-17	Fraser River W.	-14.7	2.6	16	2.6	12	Diaz 2019
Bridge River	EeRl-4	Fraser River W.	-15.4	0.4	14.1	0.5	9	Diaz 2019
Keatley Creek	EeRl-4 HP7	Fraser River W.	-16.5	1.3	13.8	2.3	21	Diaz 2019
Yale	DkRi-63	Fraser River W.	-15.1	/	/	/	/	Schulting 1994

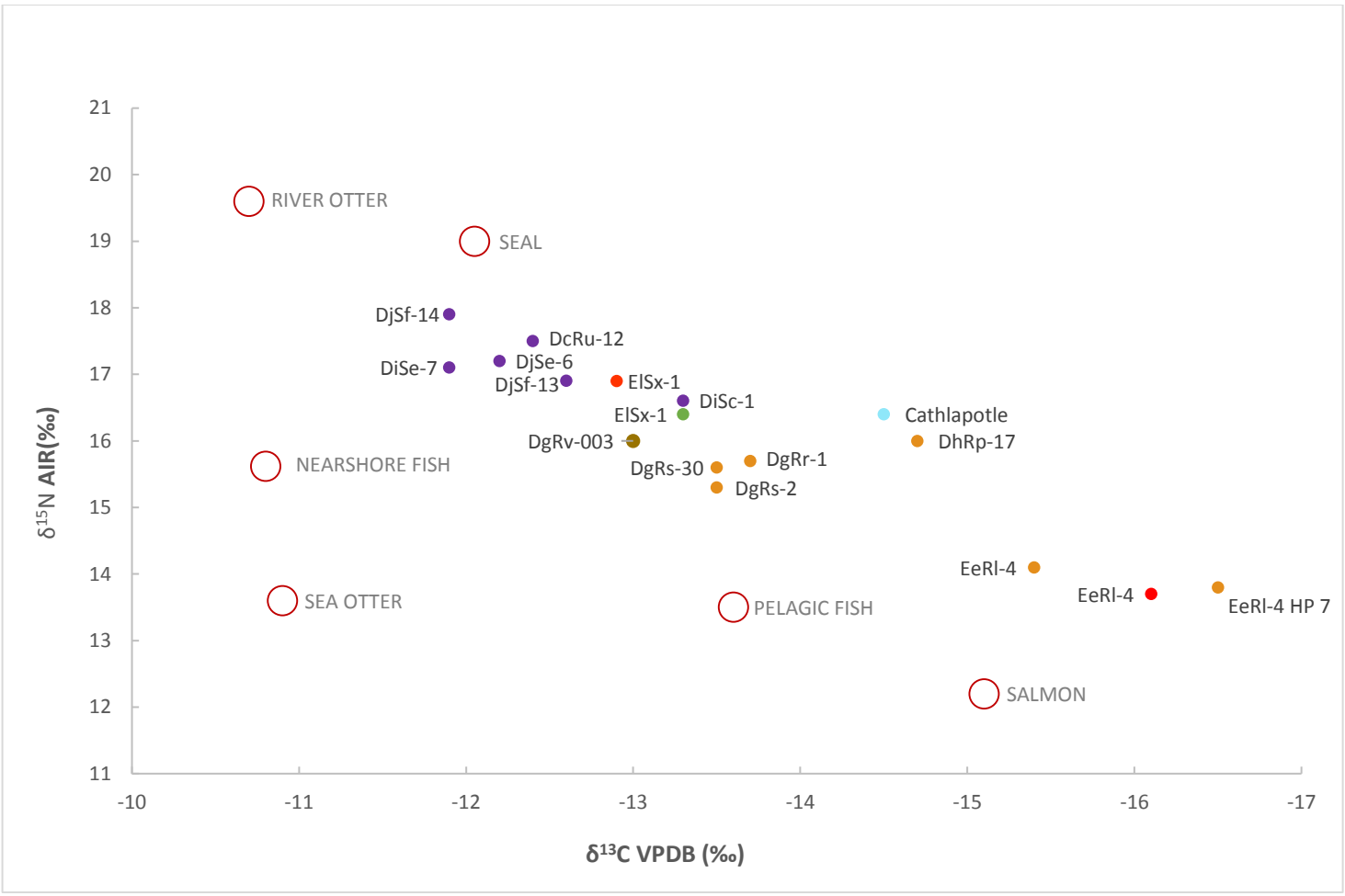

Fig. 5.12: Mean $\delta^{15}N$ and $\delta^{13}C$ values plotted against known isotope values of local fauna (see Table 5.6 for site data references) (Faunal data by Spzak et al. 2009). Different colours represent different researchers (purple = Sparrow; red = Barta 2006; orange = Diaz 2019; blue = Ames et al. 2015; brown = Grier 2006; green = Cannon et al. 1999).

Previous isotopic studies of dog and human remains from the central coast of British Columbia demonstrate that subsistence strategies changed over time as salmon resources decreased (e.g. Cannon et al. 1999; Chisholm et al. 1982; Schwarcz et al. 2014). However, the results of this study indicate that Coast Salish dogs were eating high-trophic marine diets, potentially including many fish but not specifically salmon. When plotted against other sites, geographic-specific patterns emerge (Fig. 5.12). Coastal and island sites demonstrate lower mean $\delta^{15}N$ and higher mean $\delta^{13}C$ values than inland sites, which is expected. Sites on the interior coast of Vancouver Island

demonstrate the highest mean $\delta^{15}N$ and $\delta^{13}C$ values of all, excluding Little Qualicum. The mean $\delta^{15}N$ and $\delta^{13}C$ values of Little Qualicum closely align with values produced by Cannon et al. 1999 for central coast Heiltsuk site Namu (ElSx-1).

The sample size of Little Qualicum is very small compared to the rest (n=3), reducing the accuracy of a mean value. Two of the samples from Little Qualicum fall within the same range as the rest of the dogs, while one is an outlier. That outlier, with a lower carbon value, shifted the mean outside of the range of the rest of the dogs. This discrepancy should be kept in mind while viewing the plotted data. This dog could be an outlier because of sample contamination, because the dog was treated differently than its peers, or because it simply preferred different types of food. Some dogs are fussier eaters than others are, and individual agency cannot be discounted when talking about diet.

Dogs demonstrate dietary continuity over time and space, further emphasized by this new data in conjunction with years of work by other researchers in the region. Dogs were not deprived of high-trophic foods; in fact, it appears they ate high-trophic marine foods almost entirely to the exclusion of anything else. Humans were feeding their high quality foods that required time and effort to acquire, rather than letting the dogs hunt or fend for themselves. While dogs may likely have scavenged human scraps and consumed human feces, this cannot account for the $\delta^{15}N$ and $\delta^{13}C$ of every dog. Dogs went were people went, lived where people lived, and ate what people ate. They were considered to exist as more than just *animal*, they were part of a larger community, and this is emphasized by the results of this study.

Entanglement, Relationality, & Identity

Perri (2014:2164) writes that dogs' "vast breadth of behavioural and morphological traits makes them the most adaptable land mammal on the planet." Looking at the relationship between humans and dogs within a relational framework, in which a being is constitutive through its relationships with others and aspects of its environment, a being can occupy a space between human and non-human, a space of action and relationship (Bird-David 1999). Animals, plants, places, and things can be regarded as non-human persons depending on the circumstance. The Coast Salish considered some dogs to be non-human persons, dependant on their relationship with humans –and inversely, dogs would likely have viewed certain humans as non-canid dogs, pack-mates in a way, and others as simply animals of another species that may drop tasty bits of food from time to time.

Exploring the relationships and bonds between humans and animals, specifically dogs, is necessary to interpret the significance and uses of their remains in an archaeological context and provide thorough understandings of the past. Vandergugten (2015:45) writes "humans and animals share domains of existence that influence the process of entanglement," including commonalities like time, space, food, and water, and having bodies that are structurally and functionally similar (Vandergugten 2015). These commonalities influence human culture, including art, stories, and in cosmological and mythological interpretations and narratives. The construction and retelling of these narratives over generations solidifies them in cultural consciousness (Losey et al. 2013; Vandergugten 2015). This also correlates with indigenous traditional ecological knowledge, which is a "constantly evolving way of thinking about the world" (Pierotti and Wildcat 2000:1338) in which humans and other animals are viewed as equal beings that are connected as part of the natural world (Pierotti and Wildcat 2000), contrary to popular Western beliefs.

Relational frameworks, entanglement theory, and TEK are mostly non-Eurocentric ways of looking at the relationships between individuals, providing a more holistic and accurate way of viewing the past. These relational theories also legitimize Indigenous narratives that have been deemed superstitions or fairy tales by early colonialists (Marino 2015). The term 'myth' is generally rejected because of the implication that the narrative is untrue. Many of these narratives take place in what is known as the Myth Age, a time before there was a differentiation between human and animal (Thompson and Egesdal 2008). This has been described as another dimension or reality in which typically inanimate places and objects are anthropomorphized, but in which these stories really happened (Thom 1997:12). These narratives happened within a dimension where there is no meaningful distinction between real, mythical, or supernatural beings - they all exist within the same world (Marino 2015). Suttles (1987:76) suggests, "A description of Coast Salish culture that is truly 'emic' – that is, organized by Native categories – should describe whales and bears, sasquatches and two-headed serpents, all under the same heading as part of the 'real' world of the Coast Salish." It is the movement within human interaction and engagement in which beings are constructed (Marino 2015).

In the case of the Coast Salish, it is clear that humans and dogs have maintained close bonds over several millennia. This is indicated within this project by the diets of hundreds of archaeological dog remains across the Pacific Northwest coast, the majority of which consumed diets consisting of high-trophic marine foods that would not be naturally conducive for a canid to consume, such as seal and carnivorous fish. Additionally, dogs often play major roles in traditional Coast Salish narratives, in which the line between human and dog is often blurred. The bonds and relationships between Coast Salish dogs and their humans over such a large spatial and temporal scale are evident in their narratives, their archaeological remains, and their diets.

Study Limitations

Previously Excavated Shell Midden Materials

Although the excavation of shell middens may produce huge amounts of food remains, selective preservation of material for myriad reasons limits the usefulness of counts vs. weights and other methods of faunal analysis. Excavations that took place in the 1970s may not have taken the same precautionary screening measures that are taken today to preserve tiny fish remains, such as those of the eulachon. Organic material decays very quickly compared to bone, teeth, and shell, altering our perception of shell midden contents based mainly on what is visible to us today. Additionally, Most of the dog remains for this project were fragmentary – only four mandibles were mostly intact, and many teeth were missing – making measurements for potential breed determination or for other reasons impractical. Species identification had already been completed by the time I acquired the samples.

Stable Isotope Analysis

Stable isotope analysis has become an extremely popular method to gain understanding about past diets in archaeology. This method has provided researchers with huge amounts of information previously indeterminable, but it has limitations. It is destructive and often requires large amounts of material (~2 g) per sample. If care is not taken throughout the process, cross contamination can occur, leading to inaccurate results. It can also be prohibitively expensive for many researchers.

Conclusions & Suggestions for Further Research

The objectives of this project are to find out what Coast Salish dogs were eating, and to gain a better understanding of the long-term bonds between people and dogs on the Pacific Northwest coast. The stable isotope results of this project suggest that Coast Salish dogs were consuming high-

trophic marine foods that would otherwise be largely inaccessible to them without human assistance, implying lifelong bonds and relationships between individuals and as two unique species. These results, paired with traditional narratives and radiocarbon dating, support the hypothesis that dogs in this context had the potential for personhood.

This project is the beginning of a large-scale project incorporating isotope values from dogs, and potentially other animal sources, across a pan-coastal environment. This data, in conjunction with data from other researchers (e.g. Cannon et al. 1999; Diaz 2019; Szpak et al. 2009) allows us to understand settlement and subsistence patterns over time and space within a framework that accentuates the importance of dogs as individual agents, rather than as a material. More data from more dogs throughout the Pacific Northwest Coast can be compiled to generate an even more nuanced understanding of dog diets and relationships over a larger spatial and temporal region. This data, in turn, can provide greater insight into contemporaneous human settlement and subsistence patterns.

An unexpected result of this study was the apparent lack of salmon in the diets of these dogs. Salmon has long been considered a major part of both human and dog diets along the Pacific Northwest Coast (e.g., Cannon et al. 1999; Moss et al. 1990; Monks 1977). This result can be followed up with a closer analysis of both new and previous stable isotope data from the region.

Potential for Wool Dog Isotopic Identification

The original direction for this project was potentially determining dog breed by diet within the context of these six sites (i.e., can a wool dog be identified isotopically?). Although dogs as a species can be identified isotopically because of their dietary links to humans, the visible distinction

of specific breed from diet, after some research and consideration, appears unlikely. Schulting (1994) analysed the dog fur from a Coast Salish blanket used in an infant's burial using stable isotope analysis. Schulting determined that the fur was, in fact, from a dog, because of the fur's high marine protein signature (mean $\delta^{13}C$ -15.1‰). It also matched the $\delta^{13}C$ value of the infant inside the blanket (-15.9‰) (Schulting 1994:68) and the $\delta^{13}C$ values of human bone measurements from DjRi-3 (mean -15.9‰). The blanket Schulting (1994) tested is from Yale, an interior site along the Fraser River watershed that marks the inland limits of Coast Salish territory (Duff 1952; Schulting 1994). This value is higher than the mean range of $\delta^{13}C$ -11.9‰ to $\delta^{13}C$ -13.9‰ demonstrated by the coastal sites in this project. However, it does correlate to dog values from other sites along the Fraser River watershed, where Yale is located, essentially eliminating the idea that the discrepancy could be breed-related.

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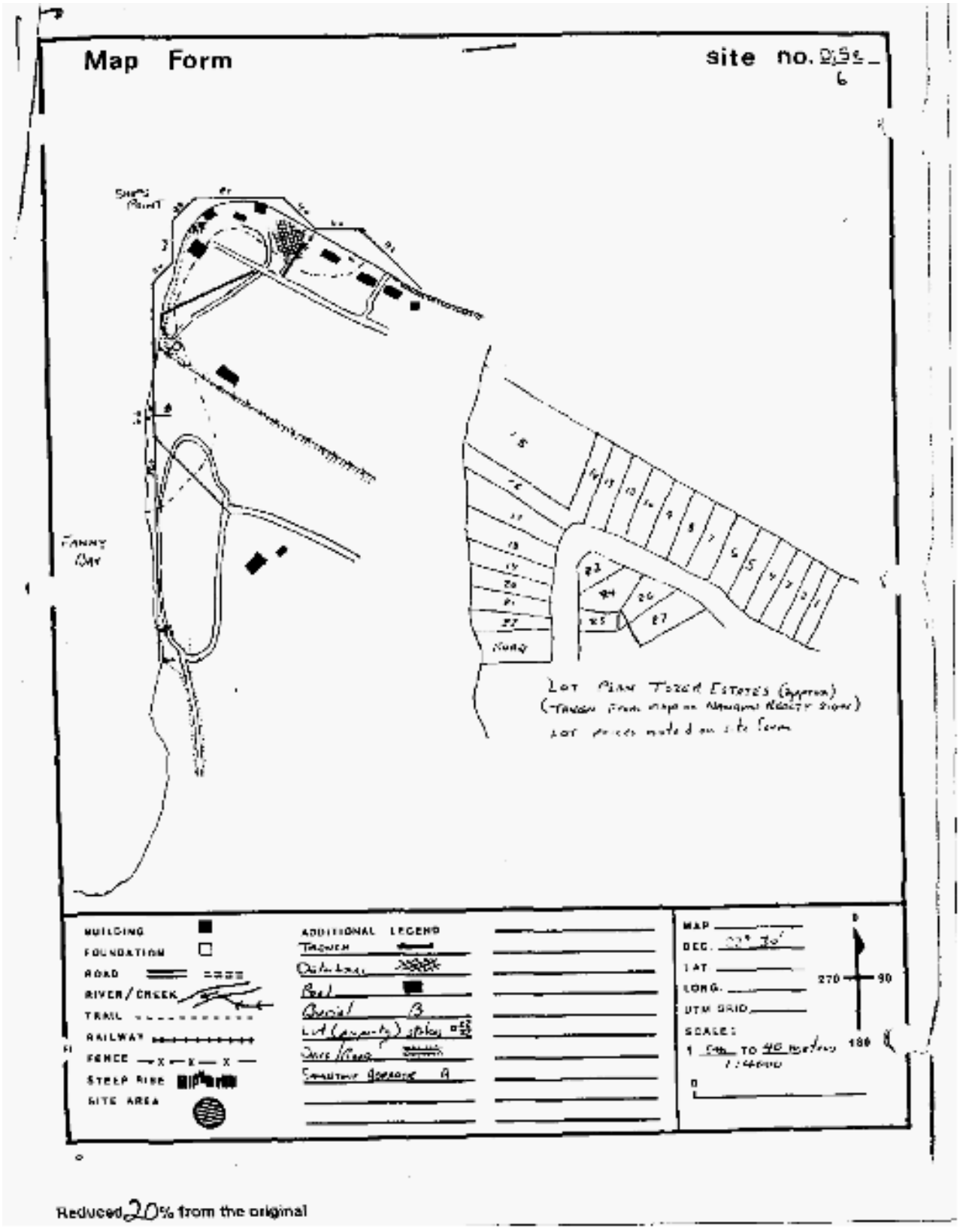
APPENDIX I: Available data on Ship's Point (DjSe-6)



British Columbia Site Inventory Form

Borden Number: DjSe-8

Protected by Legislation: YES

Identification:

Temporary Number	Site Name	Assigned By	Date Assigned
DjSe-600			

Map Reference:

GIS Populated					Historic Source				
Latitude	Longitude	UTM Easting	UTM Northing	UTM Zone	Latitude	Longitude	UTM Easting	UTM Northing	UTM Zone
49 30'17"	-124 48'27"	369132	5485134	10	493025	1244820			

Map Sheet Number	Spatial Accuracy
92F/10	Site Map (Detailed)
92F.056	Site Map (Detailed)

Accuracy Remarks

2011: site redigitized to look like boundary on original 1975 map.

Site Location:

Description	Site Access
SHIPS POINT - INCLUSIVE, (VANCOUVER IS.). NOTABLY SEVERAL LOTS BELONGING TO THE TOZER ESTATES PROJECT (N END OF SHIPS POINT PEN.).	

Street Address:

Street Number	Street Name	City	Postal Code

Site Dimensions:

Length (m)	Width (m)	Site Area	Comments
360	40	1.43	

Environment:

Elevation (metres above Sea Level)

User Elevation	GIS Elevation	Elevation Comments
0-0	-19-4016	

Biogeography

Type	Name	Description
GIS EcoRegion	Eastern Vancouver Island	
GIS VegetationZone		
GIS VegetationZone	CWHxm1	
GIS Drainage	PARKSVILLE	

British Columbia Site Inventory Form

Borden Number: DjSe-8

Tenure/Reserves:

Jurisdiction	*Tenure/Reserves T*	*Description*	*Tenure Remarks*
GIS Municipalities		Comox-Strathcona, Subd. C	
GIS RegionalDistrict		Comox-Strathcona	
GIS LandDistricts		Newcastle District	
GIS LandDistricts		Nanaimo District	

Site Typology:

Class	*Type*	*Sub Type*	*Descriptor*
PRECONTACT	Cultural Material	Subsurface	Shell Midden

Feature Description Table

Feature #	*Length*	*Width*	*Dia.*	*Depth*	*DBS from*	*DBS To*	*Shape*	*Orientation*	*Rows/Rim*	*Colour*
Feature Remarks										

Class	*Type*	*Sub Type*	*Descriptor*
PRECONTACT	Cultural Material	Surface	Lithics

Feature Description Table

Feature #	*Length*	*Width*	*Dia.*	*Depth*	*DBS from*	*DBS To*	*Shape*	*Orientation*	*Rows/Rim*	*Colour*
Feature Remarks										

Class	*Type*	*Sub Type*	*Descriptor*
PRECONTACT	Human Remains		Burial

Feature Description Table

Feature #	*Length*	*Width*	*Dia.*	*Depth*	*DBS from*	*DBS To*	*Shape*	*Orientation*	*Rows/Rim*	*Colour*
Feature Remarks										

Cultural Material :

Type	*Status*	*Repository*	*Date*
Artifact	Collected		

Details

RBCM, Acc 1-101, 74-39 101. Goodnall, Mr., Royston: Included 3 pendants, sandstone abrader, 1 ground slate knife, ground slate fragment, bone harpoon, unilaterally barbed, 2 worked bone fragments, 92 incised stones, detritus.

APPENDIX II: All Samples Retrieved from RBCM

Site Name	Borden #	Artifact Number	Material	Unit	Depth (cm)	Year
Deep Bay	DiSe-7	2660	Bone, Tooth	73-5	120-130	1975
Deep Bay	DiSe-7	2608	Bone, Tooth	73-5	110-120	1975
Deep Bay	DiSe-7	2609	Bone, Tooth	73-5	110-120	1975
Deep Bay	DiSe-7	2605	Tooth	73-5		1975
Deep Bay	DiSe-7	2617	Tooth	73-1	60-70	1975
Deep Bay	DiSe-7	2616	Tooth	73-1	50-70	1975
Deep Bay	DiSe-7	2625	Tooth	73-5	120-130	1975
Deep Bay	DiSe-7	2005	Tooth	73-5	70-80	1975
Deep Bay	DiSe-7	2603	Bone, Tooth	73-3		1975
Deep Bay	DiSe-7	2602	Bone, Tooth			1975
Deep Bay	DiSe-7	2602	Tooth	73-3		1975
Site Name	**Borden #**	**Artifact Number**	**Material**	**Unit**	**Depth (cm)**	**Year**
Little Qualicum	DiSc-1	2406	Tooth			1976
Little Qualicum	DiSc-1	2412:d	Tooth			1976
Little Qualicum	DiSc-1	2412:2	Bone, Tooth			1976
Site Name	**Borden #**	**Artifact Number**	**Material**	**Unit**	**Depth (cm)**	**Year**
Tsable River	DjSf-14	2231	Tooth		3.90-4.00	1973
Tsable River	DjSf-14	2236	Tooth		4.50-4.60	1973
Tsable River	DjSf-14	2212	Tooth	TC1	140-160	1973
Tsable River	DjSf-14	2246	Tooth		1.50-1.60	1973
Tsable River	DjSf-14	2214	Tooth		140-160	1973
Tsable River	DjSf-14	2263	Tooth		4.5-4.6	1973
Tsable River	DjSf-14	2251	Tooth	TC1	1.20-1.50	1973
Tsable River	DjSf-14	2218	Tooth	TC1	140-160	1973
Tsable River	DjSf-14	2233	Tooth		4.40-4.50	1973
Tsable River	DjSf-14	2213	Tooth		1.40-1.60	1973
Tsable River	DjSf-14	2241	Tooth	D	4.0-4.1	1973
Tsable River	DjSf-14	2245	Tooth	TC1	4.4-4.6	1973
Tsable River	DjSf-14	2255	Tooth	A	4.0-4.1	1973
Tsable River	DjSf-14	2252	Tooth	TC1	1.20-1.40	1973
Tsable River	DjSf-14	2264	Tooth	B	4.5-4.6	1973
Tsable River	DjSf-14	2244	Tooth	TC14	4.40-4.60	1973
Tsable River	DjSf-14	2217	Tooth	TC1	140-160	1973
Tsable River	DjSf-14	2247	Tooth			1973
Tsable River	DjSf-14	2242	Tooth	C	4.30-4.40	1973
Tsable River	DjSf-14	2215	Tooth	TC1	140-160	1973
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973

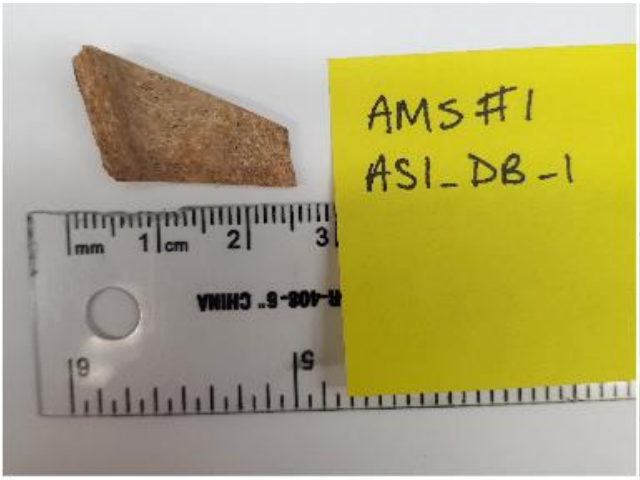
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973
Tsable River	DjSf-14		Tooth	A	4.10-4.20	1973
Tsable River	DjSf-14		Tooth	C	4.0-3.5	1973
Tsable River	DjSf-14		Tooth	TC14	4.2-4.4	1973
Tsable River	DjSf-14		Tooth	TC14	4.2-4.4	1973
Tsable River	DjSf-14		Tooth	TC14	4.2-4.4	1973
Tsable River	DjSf-14		Tooth	TC14	4.2-4.4	1973
Tsable River	DjSf-14		Tooth	TC14	4.2-4.4	1973
Tsable River	DjSf-14	2243	Tooth	H	4.10-4.20	1973
Tsable River	DjSf-14	2243	Bone, Tooth	H	4.10-4.20	1973
Tsable River	DjSf-14	2247	Bone, Tooth	C	L9	1973
Tsable River	DjSf-14	2247	Tooth	C	L9	1973
Tsable River	DjSf-14	2247	Tooth	C	L9	1973
Tsable River	DjSf-14	2247	Bone, Tooth	C	L9	1973
Tsable River	DjSf-14	2247	Bone, Tooth	C	L9	1973
Tsable River	DjSf-14	2247	Bone, Tooth			1973
Tsable River	DjSf-14	2223	Bone, Tooth	TC13	1.60-1.80	1973
Tsable River	DjSf-14	2237	Bone, Tooth	TC3	280-3.00	1973
Tsable River	DjSf-14	2243	Bone, Tooth	H	4.10-4.20	1973
Tsable River	DjSf-14	2253	Bone, Tooth	TC3	3.40-3.60	1973
Tsable River	DjSf-14	2265	Bone, Tooth	A	3.90-4.00	1973
Tsable River	DjSf-14	2237	Bone, Tooth	TC3	2.80-3.00	1973

Site Name	Borden #	Artifact Number	Material	Unit	Depth (cm)	Year
Buckley Bay	DjSf-13	2113	Bone, Tooth	TC6	4.40-4.60	1974
Buckley Bay	DjSf-13	2113	Bone	TC6	4.40-4.60	1974
Buckley Bay	DjSf-13	2103	Tooth	TC7	7.20-7.40	1974
Buckley Bay	DjSf-13	2102	Bone, Tooth	TC7	7.00-7.20	1974
Buckley Bay	DjSf-13	2106	Bone	TC1	1.20-1.40	1974
Buckley Bay	DjSf-13	2106	Bone and Tooth	TC1	1.20-1.40	1974
Buckley Bay	DjSf-13	2106	Bone	TC1	1.20-1.40	1974

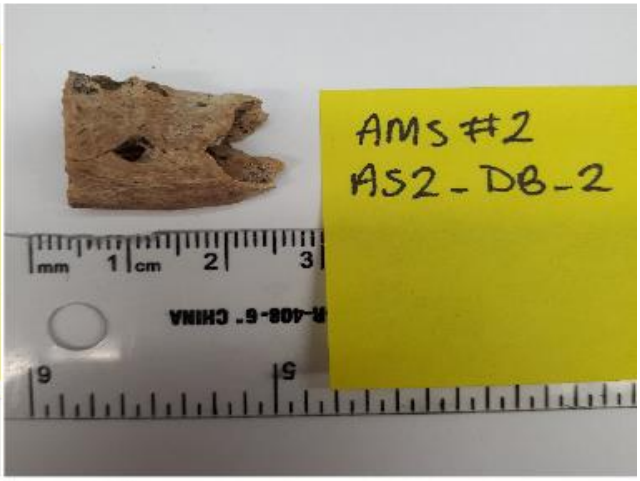
Site Name	Borden #	Artifact Number	Material	Unit	Depth (cm)	Year
Ship's Point	DjSe-6	1209	Bone, Tooth	TC4	2.20-2.30	1973
Ship's Point	DjSe-6	1217	Bone	TC2	2.20-2.30	1973
Ship's Point	DjSe-6	1210	Bone, Tooth	TC6	2.20-2.30	1973
Ship's Point	DjSe-6	1212	Bone, Tooth	TC2	2.40-2.50	1973
Ship's Point	DjSe-6	1215	Bone, Tooth	TC4	2.30-2.40	1973
Ship's Point	DjSe-6	1213	Bone, Tooth	TC2	2.50-2.60	1973
Ship's Point	DjSe-6	1211	Bone	TC4	2.20-2.30	1973
Ship's Point	DjSe-6	1214	Bone, Tooth	TC4	2.30-2.40	1973
Ship's Point	DjSe-6	1207	Bone, Tooth	TC4	2.30-2.40	1973
Ship's Point	DjSe-6	1216	Bone, tooth	TC3	2.20-2.30	1973
	DjSe-6	1216	Bone, tooth	TC4	2.20-2.30	1973

Site Name	Borden #	Artifact Number	Material	Unit	Depth (cm)	Year
Maple Bank	DcRu-12	4043	Bone, tooth			1977
Maple Bank	DcRu-12	2135	Tooth	Pits A and B		1977
Maple Bank	DcRu-12		Tooth	Pit B, Layer P	145	1977
Maple Bank	DcRu-12	379	Tooth	S 40 E 162	25	1977
Maple Bank	DcRu-12		Tooth	Pit B, Lv9, Lyr B	95	1977
Maple Bank	DcRu-12	402	Tooth	S32E142,eu5 lv4	Screen	1977
Maple Bank	DcRu-12	1104	Tooth	S33 E142	143	1977
Maple Bank	DcRu-12	1840	Tooth	S22 E44		1977
Maple Bank	DcRu-12	671	Tooth	S36 E146		1977
Maple Bank	DcRu-12	4095	Tooth			1977
Maple Bank	DcRu-12		Tooth	S34 E144	43.2	1977
Maple Bank	DcRu-12	1543	Tooth	S20E140 lv22	screen	1977
Maple Bank	DcRu-12	1822	Tooth	PitB lv10 lyA	100	1977
Maple Bank	DcRu-12	258	Tooth	S34E144	50.5	1977
Maple Bank	DcRu-12	4090	Tooth			1977
Maple Bank	DcRu-12	17	Tooth			1977

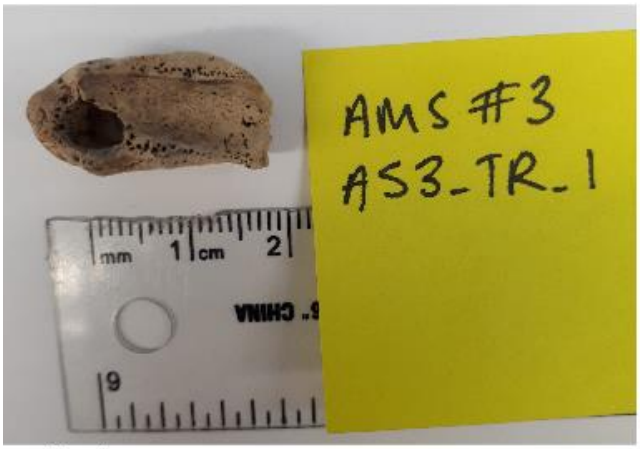
APPENDIX III: Samples Selected for Radiocarbon Dating



Deep Bay 1



Deep Bay 2



Tsable River 1

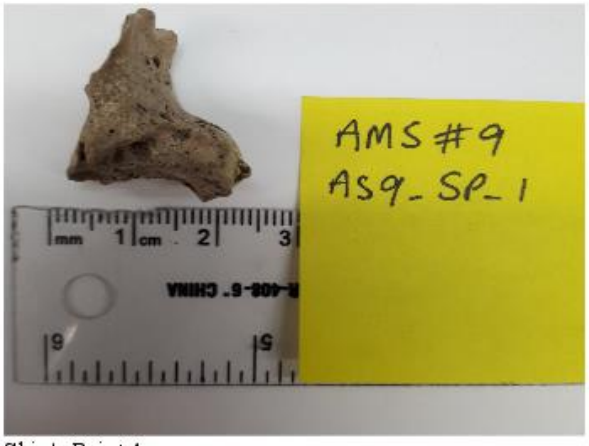
Tsable River 2

Little Qualicum River 1

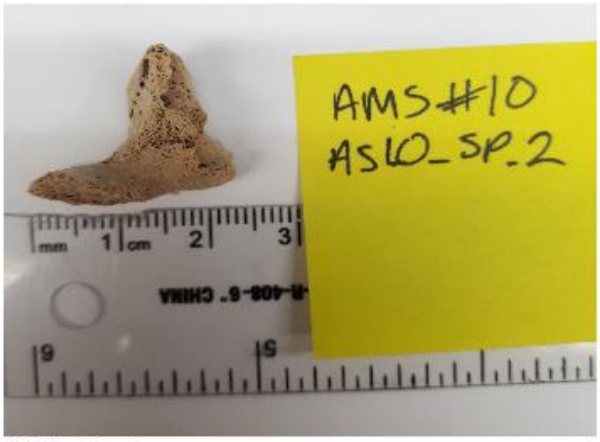
Buckley Bay 1

Buckley Bay 2

Maple Bank 1

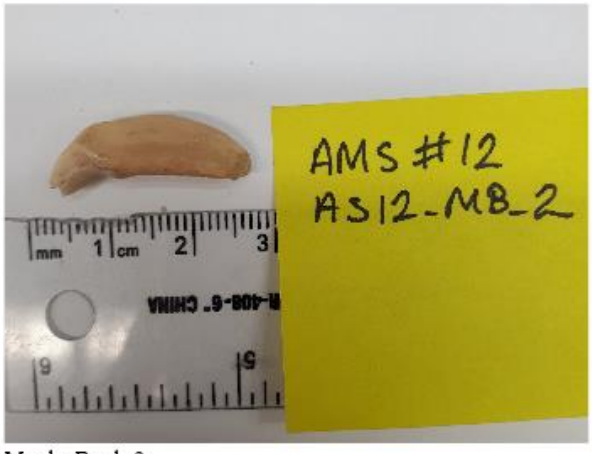


Ship's Point 1



Ship's Point 2

Little Qualicum River 2



Maple Bank 2

APPENDIX IV: Stable Carbon and Nitrogen Results for All Samples

Sample ID	Delta 13C (‰)	Mass Fraction C (%)	Delta 15N (‰)	Mass Fraction N (%)
7024	-12.34	27.6	16.6	9.76
7025	-12.09	37.7	16.14	13.14
7026	-11.76	42.5	16.05	14.94
7027	-12.58	26.5	17.6	9.33
7028	-12.75	31.3	16.33	11.13
7029	-14.37	14.83	17.14	5.14
7031	-12.57	22.2	17.04	7.81
7030	-15.07	13.55	14.79	3.68
7033	-12.29	15.3	18.41	5.27
7034	-13.11	31.6	16.57	11.24
7192	-12.02	14.84	18.5	5.13
7032	-12.15	14.01	18.4	4.79
7035	-12.9	25.1	17.28	8.4
DB-4461-B	-10.99	43.1	16.71	15.5
DB-4462-B	-11.32	43	15.93	15.4
DB-4463-B	-11.39	42.8	17.24	15.5
DB-4464-B	-11.79	41.1	16.97	14.73
DB-4465-B	-12.97	42.4	15.78	15.3
DB-4466-B	-13.04	42.6	16.09	15.3
LQ-4467-B	-12.7	43.3	16.25	15.6
TR-4468-B	-12.14	42.4	17	15.3
TR-4469-B	-11.4	43.5	17.17	15.7
TR-4470-B	-11.52	42.3	16.34	15.4
TR-4471-B	-11.81	43.7	17.6	15.9
TR-4472-B	-12.85	41.6	16.04	15
TR-4473-B	-12.05	43.6	17.13	15.9
BB-4474-B	-11.96	42.9	17.64	15.6
BB-4475-B	-11.91	44.5	17.46	16.3
BB-4477-B	-12.4	41.7	16.45	14.98
BB-4478-B	-12.23	41.5	15.44	14.68
MB-4479-B	-12.66	42.3	16.78	15.3
SP-4480-B	-12.25	43.3	17.43	15.5
SP-4481-B	-11.65	44	15.89	16
SP-4482-B	-12.77	44.3	16.6	16
SP-4483-B	-12.67	42.7	16.83	15.4
SP-4484-B	-12.18	43	17.13	15.5
SP-4485-B	-12.15	43.4	17.76	15.5
SP-4486-B	-12.34	43.3	16.93	15.5
SP-4487-B	-11.63	41.9	17.2	15.1
SP-4488-B	-12.38	42.2	17.37	15.1

SP-4489-B	-11.89	43.9	17.09	15.7
SP-4490-B	-11.89	43.7	17.5	15.7
DB_4602_T	-11.2	45.1	18.68	16.2
DB_4603_T	-11.76	44.3	17.57	16.1
DB_4604_T	-12.63	44.7	18.85	16.3
DB_4605_T	-11.84	45.1	18.36	16.2
TR_4606_T	-11.75	44	19.24	15.8
TR_4607_T	-12.23	44.9	19.54	16.2
TR_4608_T	-11.59	43.3	18.7	15.7
TR_4609_T	-12.02	44.4	18.69	16.1
TR_4610_T	-11.46	42.8	18.03	15.6
TR_4611_T	-11.59	42.9	19.17	15.4
TR_4612_T	-11.36	42.9	18.54	15.6
TR_4613_T	-12.33	42.7	18.38	15.5
MB_4614_T	-13.2	45.2	17.77	16.2
MB_4615_T	-12.32	43.1	16.23	15.6
MB_4616_T	-12.37	39.8	18.35	13.93
MB_4618_T	-11.89	44.5	17.8	16.2
MB_4619_T	-11.87	43.5	17.88	15.8
BB_4620_T	-12.25	42	18.54	15

APPENDIX V: Faunal data from Haida Gwaii

species	d13C	d15N	Reference
Ancient murrelet	-14.2	17.9	Szpak et al. 2009
Cabezon	-9.6	15.4	Szpak et al. 2009
Dogfish	-12.1	13.4	Szpak et al. 2009
Greenling	-10.7	14.6	Szpak et al. 2009
Irish lord	-9.1	15.5	Szpak et al. 2009
Lingcod	-10.4	17.2	Szpak et al. 2009
Pacific cod	-11.4	17.3	Szpak et al. 2009
Pacific halibut	-11.1	17.5	Szpak et al. 2009
prickleback	-12.2	13.4	Szpak et al. 2009
ratfish	-10.3	16	Szpak et al. 2009
rockfish	-11.1	15.9	Szpak et al. 2009
herring	-13.6	13.5	Szpak et al. 2009
salmon	-15.1	12.2	Szpak et al. 2009
porpoise	-12.3	19.3	Szpak et al. 2009
harbour seal	-11.5	18.4	Szpak et al. 2009
fur seal	-12.6	19.6	Szpak et al. 2009
sea lion	-12	19.9	Szpak et al. 2009
dolphin	-11.3	16.1	Szpak et al. 2009
river otter	-10.7	19.6	Szpak et al. 2009
sea otter	-10.9	13.6	Szpak et al. 2009
whale	-13.1	17.3	Szpak et al. 2009
black bear	-19.3	4	Szpak et al. 2009